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Explosion of the Locomotive "Lehigh."

BY L. F. LYNE, M. E.

The illustration shown in Fig. 1 represents the back part of the boiler of the locomotive Lehigh, No. 15, D., L. & W. R. R., Morris & Essex Div., which exploded at the Hoboken (N. J.) depot, Oct. 28th, 1879, at about 8.45 P. M., killing the engineer on the spot and injuring the fireman so that he died a few days after. The locomotive had been coupled up to the train and all was ready, and the signal had been given to start; the steam was escaping from the pop safety valve, as usual, and nothing to indicate the terrible catastrophe which followed a few moments later. The train began to move, and had progressed from six to eight feet, when a deafening report was heard, as if a heavy cannon had been discharged, and the air was filled with bits of iron and *debris* flying in all directions The board fence on the side of the boiler where the explosion occurred was blown against a horse car, severely injuring the passengers, and it was reported that the "driver suffered the loss of his entire clothing," but evidence has not been found to corroborate this statement. The locomotive was evidently lifted from the ground and thrown over on the left side, as the driving wheels on the left side were found lying across the rail, and inside of the same. The cab together with the upper works of the boiler were completely stripped off. The air being filled with steam and hot water, besides the *debris* mentioned, it was some moments before an examination could be made. When the steam cleared away, a rent was found in the right side of the wagon top, from the seam B, in Fig. 1, and following the edges of the crow feet, both top and bottom, making an opening 18″ wide, being torn completely away from the boiler, at C (a distance of 5ft. 6″ from B), and was thrown, in the direction indicated by the round brace, D, a distance of about 150 feet back, and about 20 feet to the left, of the engine. The piece was afterwards found, as shown in Fig. 2, on the top of a shed.

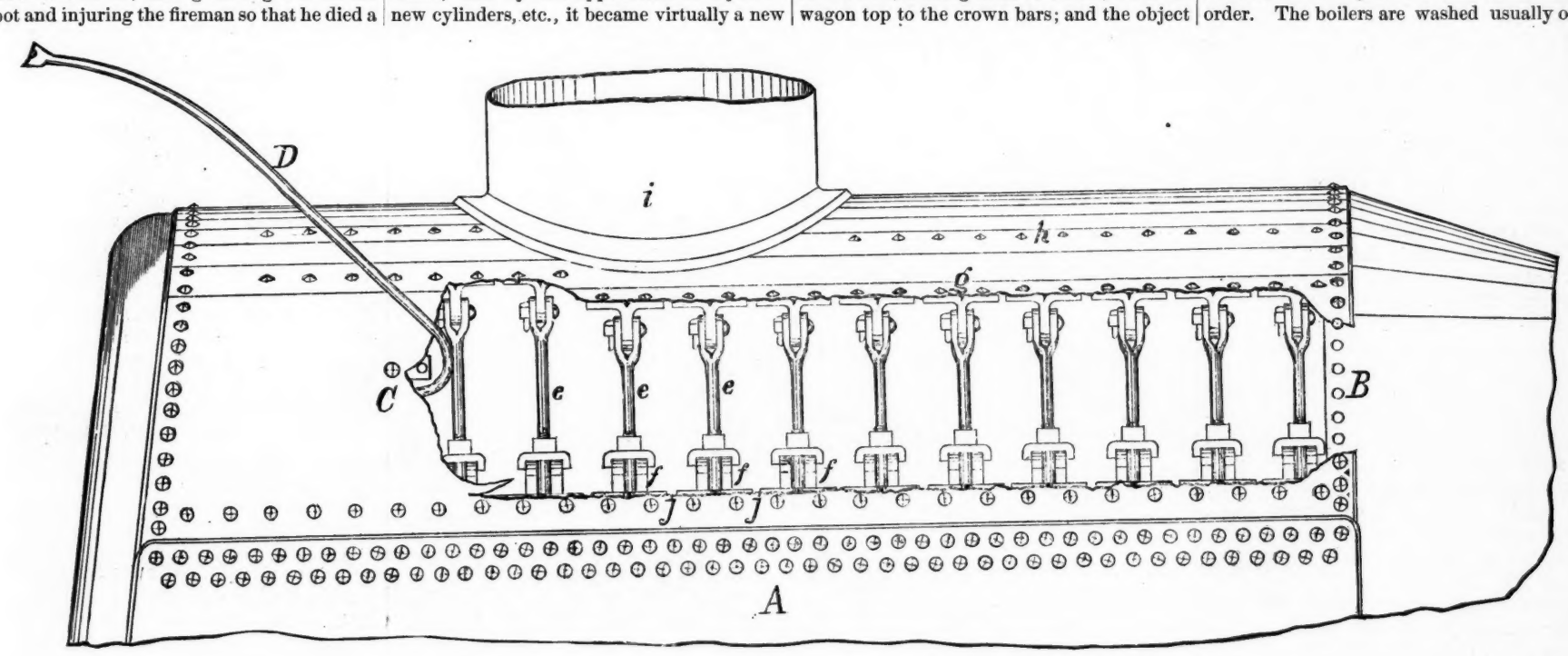


Fig 1.

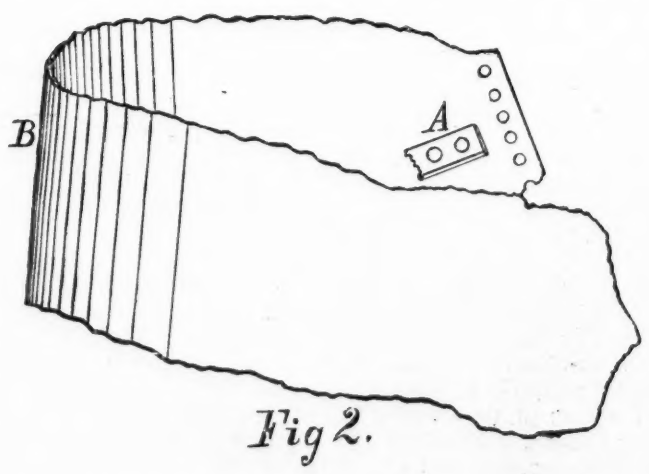


Fig 2.

The locomotive Lehigh was what is known as an eight wheel passenger engine, was formerly a wood burner, and came on the D., L. & W. R. R. in 1865. In 1874 the engine was remodeled by changing the construction of the boiler to adapt it to the burning of anthracite coal (this was a new boiler). In consequence of these alterations it became necessary to lengthen out the frame, and by the application of a pair of new cylinders, etc., it became virtually a new engine. The iron of which the boiler was composed, was stamped with C. H. No. 1 (charcoal iron) made by the Abbott Iron Co., of Baltimore, Md., was a trifle less than $\frac{5}{8}$″ thick. Specimens of this were afterwards tested and are said to have stood a tensile strain of about 46,000 lbs. per square inch.

These specimens were taken from the piece which was torn out, and, considering the fact that the iron was undoubtedly strained up to, if not beyond, its elastic limit, when it was torn from the boiler, being bent up and then straightened again, would necessarily reduce its tensile strength. Doubtless specimens taken from the body of the sheet, remaining on the boiler, would show greater tensile strength. Referring to Fig. 1, the reader will observe that the fire-box is of pretty good length, which is necessary for hard coal. The total length of the sheet on the wagon top is about 6 feet 11 inches, to which is attached four rows of braces, two on each side. The distance between the center of the row of braces *h*, and the corresponding one on the opposite side of the boiler is 17″, and 6″ from these, there is another row, *g*, on each side. In each of these rows there are fourteen braces made of 1″ round iron, making in all 56 braces, from the wagon top to the crown bars; and the object of these braces is not, as some suppose, to strengthen the shell, but to support the crown sheet, and hold it up. In addition to these braces there are 15 cross braces, attached to crow-feet (shown at *j*, *j*′), on opposite sides of the shell, so as to hold it when the stay bolts break, as they ultimately will, owing to the unequal expansion of the shell and the sides of the fire-box. It will be observed from the illustration that the piece was torn from the solid sheet, and does not touch either seams or rivet holes, except at the point B where the wagon top joins with the sloping part of the boiler. The rivets used were $\frac{11}{16}$″ in diameter, and these at B and other circular seams are placed $1\frac{7}{8}$″ from center to center. The side seams at A are double-riveted. The dome, *i*, is 23″ in diameter, and is located about 22″ from the back end of top sheet. The safety or pop valves on the D., L. & W. R.R. are set to blow off at 130 lbs. per square inch, and evidence goes to prove that this safety valve was blowing at the time the signal was given to start the train. The steam gauge was tested the 29th inst. and found correct. The engineers have strict orders not to tamper with a pop valve under any circumstances, and to report the same when out of order. The boilers are washed usually once every month or six weeks. A specimen of the iron which was knocked off near the seam B showed a small amount of crystallization which was discovered on one edge about $\frac{1}{32}$″ thick, also a number of scattered crystals which was undoubtedly caused by a piece of crystallized iron being put into the ball at the time the sheet was made, as no other similar indications were discovered, and the present one was not sufficient to materially weaken the sheet, as the space covered was very small. The crown bars are made of flat bars $\frac{3}{4}$″ thick and $4\frac{1}{2}$″ wide, fastened together at the ends, and fastened to the crown sheet by bolts put up from the inside of the fire-box with a plate having gib ends placed across the top of the bars and held by a nut, as shown in the cut.

The practical testimony of Henry Waterman, M. E, as a mechanical expert, which was given at the coroner's inquest, brought out some very interesting features as to how the rupture took place and how it ended. Henry Waterman, is probably too well known as a practical scientific man to require an introduction to the engineering, or mechanical community, having begun his apprenticeship at the machine trade in 1830 in N. Y., and began the practice of engineering in 1838, having been constantly employed in this branch of business since that time, and is said to be the original inventor of the pop safety valve. He stated that he had thoroughly examined the locomotive Lehigh, and expected to find some weak spot but found none. He then went into a general description of the boiler and discussed its shape, distribution of braces, stay

bolts, etc., in substance much the same as that already given. It was also stated that there are hundreds, and perhaps thousands, of locomotives running to-day without any other support for the crown sheet except the crown bars, and six or eight braces from the inside of the dome to the crown bars.

This boiler, then, has the four rows of braces (already mentioned) connected with the crown bars and the arch, or shell, of the boiler; also the cross braces between each of the crown bars, not generally used in other boilers. Mr. Waterman here stated that he never saw, during his whole practice, a boiler better constructed, and that seemed to anticipate every strain that might be brought to bear upon it, than did this one; and, judging of it by all the rules known to practical science, the boiler was, at least, 400 per cent. to 500 per cent. stronger than the requirements for the pressure to be carried. Calculations had also been made which show, provided all the braces were taken out, the inside strength of a sectional square inch of iron (with usual pressure allowed this boiler), to be about 10,000 lbs. per square inch, or about five tons.

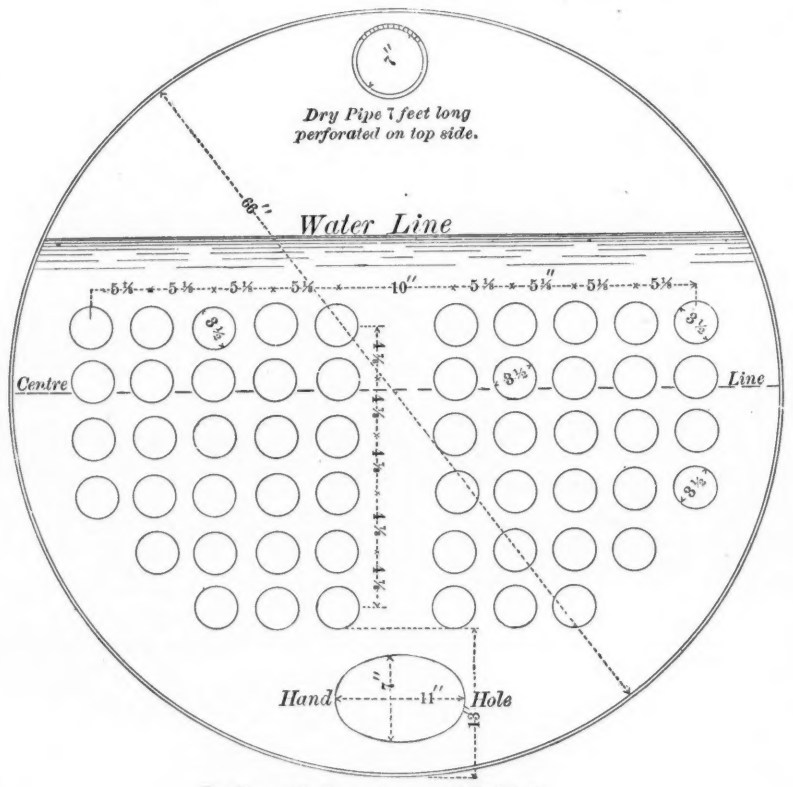
The average boiler iron of the country will stand about 50,000 lbs., or is calculated at that strength. The braces themselves are shown by this boiler, as it stands, to be strong enough to hold the entire pressure which they did, or, in other words, the whole top ought to have gone off when the sheet was broken, but it did not, therefore, the braces showed sufficient strength to hold the entire rupture at the first row of braces.

The workmanship is faultless, from the fact that every part that relates to workmanship remains intact, and there is nothing gone from the boiler except the piece of the sheet torn out (as shown in Fig. 2). There was nothing to indicate any weakness in the sheet, generally speaking. The reputation of the manufacturers of the iron used in the ruptured sheet is to make the best material, and is so considered by railroad men. An examination was made with a magnifying glass the whole length of the fractured sheet, which revealed nothing in the shape of crystallization or corrosion; the fractured edge was of that fine appearance due to refined fine iron. The rows of braces along the top of the arch are placed there to support the crown sheet, and do not add to the strength of the arch. The crown sheet, being the weakest part of a locomotive boiler, requires the best support. A row of braces along the center of piece torn out, on account of their angularity, would have been less support to the crown sheet, than where they are at present, and would not have prevented an explosion. There was no evidence to indicate what pressure was on the boiler at the time of the explosion, which could only be shown by actual test. The water could not have been low, as there was no indication of it, as there certainly would have been had it occurred. The opinion of Mr. Waterman is, that iron does not weaken by a steady strain, but blows or sudden strains will crystallize the same, and that a boiler will not necessarily explode by opening and closing the throttle suddenly, except, possibly, in case of the slipping of the wheels, when a tremendous jar would be given to the boiler. Steam gauges and safety valves require constant attention and should agree with each other.

When a locomotive starts from a station, the water in the boiler does not start the same instant with the engine, but is pushed back to the back end of the boiler, but not in such a way as to endanger the safety of the boiler. In regard to the thickness of the iron, when the thickness is increased beyond a certain limit it is very materially weakened, owing to unequal expansion.

Owing to the deaths, by the accident itself, of the engineer and fireman, the only two men who would have been able to testify to matters of fact, as distinct from inference, the precise cause of the explosion is a very difficult problem. The evidences, in this case, are that the strain was uniform over the entire surface of the piece which was blown out. Judging from the fold of this piece and the direction it took, after being separated from the boiler, it probably gave way in the center, at the lower edge (shown at B, in Fig. 2. A represents the end of the brace, D, in Fig. 1), and took a direction outward, tearing away the riveting at the front (the rivets were sheared off at B). It was then thrown over and upward until it tore away at the upper part, and, by the momentum given to the sheet by this action, it was carried over to the left of the engine, which accounts for its being found in the position where it was afterwards discovered, the rupture taking place on the right side of the engine, together with the discharge of steam and water, the recoil of which threw the engine over to the left. Boilers are generally thrown opposite the blast. Undoubtedly, the braces prevented the whole top from being blown off, but more braces would not have prevented an explosion, for obvious reasons.

Mr. Waterman also stated that he never before, in all his practice, saw a boiler in which every strain seemed to be anticipated, as in this boiler, and that in this case he would have slept on it. When a sheet breaks, or a rivet gives way, an additional strain is thrown upon its neighbor, and the pressure does not lessen as fast as the tendency to tear increases.



Boiler 14 feet Long 80 H.P.

The theory of this witness and other experts is—that the reaction of the internal forces within the boiler upon one another was excited up to a degree beyond the strength of the boiler to withstand, and a rupture became unavoidable.

The designation, "forces," as employed in the above testimony, seems to be an indefinite one, but, divested of all mystery, it may be understood to include such agencies as the shock caused by the sudden rising and falling of the water when the pressure of the steam is released unequally by the sudden opening and closing of the throttle, &c. This shock, or reaction, is intensified by a succession of sudden openings and closings of the throttle, especially when acting in connection with the slipping of the driving wheels.

Every locomotive engineer who treats his engine as a passsionate man would be likely to treat a balky horse is subject to the same danger. When a locomotive throttle is opened and the wheels slip, the throttle must, necessarily, be closed, but, before opening it again, a few moments should be allowed for the disturbed forces, previously described, to return to their normal condition. I condemn the practice of opening and closing the throttle or any other large valve suddenly, as accident is frequently caused through such carelessness.

It is said that there is not a good machinist out of employment in Westerly or Pawtucket, Rhode Island.

Boiler Proportion and Construction.—Riveting and Staying.

BY WM. H. HOFFMAN, M. E.

It has been determined by many experiments that the use of steel rivets increases the cost of construction, by reason principally of the loss by overheating and burning, while in hammering they often chill so rapidly that the heads are easily knocked off; this trouble showing itself even when mild steel is used. A steel rivet should only be used where the system of machine riveting is on the hydraulic plan.

Machine processes in all cases close the joints and fill the holes better than hand riveting, as the whole body of the rivet is reached by the pressure of the machine, but I believe that in every kind of machine riveting, pressure rings surrounding the rivet on both sides of the plates should be used to assist in bringing the joint home and to prevent the sheets from being separated by the squeezing of the rivet while very hot, in a transverse direction under or between the sheets, though in hydraulic riveting the pressure is so gradual that the partial cooling of the rivet prevents it from "bulging" and separating the joints.

In drilling or reaming plates it is easy to slightly round the corners of holes on both sides of the sheets, thereby reducing the tendency to shear all of twenty per cent., and punched holes should have the corners reamed in like manner.

There is one point in the construction of a boiler that often receives very slight attention, viz.: the forming or forging, and fastening of crow feet or stay lugs to shell and heads. It is not a rare thing to find crow feet forged of flat bar iron strong enough to resist with perfect safety a working strain of 40,000 lbs. fastened to the shell of a boiler with two ⅝" rivets and these receiving the stress at an angle of 45°.

I think that a neat and strong crow foot can be dropped or rolled with two, three and even four webs to receive rivets; these can be heated and bent to any form desired. This method would certainly establish a uniform standard as to strength, and would materially reduce the cost of manufacture in the shop, besides the advantage in having room for extra rivets.

The stays should be of the best material hammered from the merchant bar. Holes in the ends rimmed to size. The stay pins should be turned and drilled to receive annealed wire guard pins. Where threads are used the parting of rod on which thread is cut should be enlarged, so that the bottom of thread will have the same sectional area as the body of stay rod. Continuous head stays should have steel expansion collars to allow for expansion of tubes. Collars must be of steel. Every stay rod should be so arranged that it can be removed from the boiler and examined and tested, and wherever pitting and wasting is discovered the stay should be condemned, and a perfect one inserted.

Now some boiler builder will say this is all very fine with your hammered stays, turned pins, rimmed holes, etc., but who will pay for it? But nevertheless, my friend, this is just what boiler-making is coming to, and the purchaser will pay for the extra work and reduce his rate of insurance; and with boilers well designed with a view of perfect cleaning and inspection perhaps he will not insure at all, as he will naturally feel as proud of the boiler as of the engine, and nearly every owner of a good engine will insist on its being regularly inspected and cleaned.

* * * * Since my last article on Boiler Proportion and Construction, I have had two inquiries in regard to the details of arranging fifty-four (54) 3¼-inch tubes in a 66" diameter shell. There is no secret about the method, Mr. Editor, and I herewith send an end view sketch, showing the design as described. Although I rate this boiler as 80 H. P., it will generate steam for 90 indicated H. P., and will not lift the water. When set, there are 800 square feet of heating surface exposed.

Horse-power of Steam Engines.

Editor of Machinist:

I notice you are frequently beset by correspondents in relation to estimating the horse-power of steam engines, and, though rules and formulæ have been published in your paper at different times, very few employ them correctly. For this reason I think a few remarks on the subject might not be out of place. There are three conditions necessary to know before we can estimate what power an engine is capable of exerting, viz: Area of piston, steam pressure in pounds per square inch, and travel of piston in feet per minute. Even then we can only approximate its power; but, to know the amount of work an engine is performing, it is actually necessary to know two other conditions, viz: point of cut-off and average pressure during the whole length of the stroke. This latter condition is the most difficult of all to realize. Take, for instance, two engines with the same bore of cylinder and stroke of piston, as nearly alike as mechanical skill can make them, and working with the same pressure per gauge. They would not develop equal power, because the steam pipe of one might perhaps be long, and contain many right angle bends, and it, as well as the cylinder, be located in a cool place, and unprotected from the influence of the atmosphere, while in the case of the other engine, the steam pipe may be comparatively short and straight, and, as well as the cylinder be protected with some good non-conducting substance.

One of your correspondents states that he estimated the power of his engine by the following conditions, viz: Area of piston, revolutions, and pressure, which was 100 pounds per square inch, by gauge, but he neglected a very important factor in his calculations, viz: the point of cut-off. Though the pressure may have been 100 pounds per square inch by gauge, it might not average over 50 for the full stroke of the piston. Some manufacturers of automatic cut-off engines claim that the full boiler pressure is realized in the cylinder at the commencement of each stroke, but such assertions must be taken for what they are worth. I do not actually believe that over ⅔ of the boiler pressure can be realized in any engine that was ever built, and not more than ½ in the majority of engines, if (as is claimed in "Engineering Popularized," and by other high authorities) great fluctuations of temperature take place in the piston and the walls of the cylinder at each stroke, and as the piston is continually receiving from the incoming steam, the momentum of which is diminished by its passage through long, crooked pipes and elbows, and its affluent velocity retarded by having to ooze through one or more intricate valves. For the foregoing reasons it is very evident

that there must be a great difference between boiler pressures, and that realized in the cylinders of steam engines.

The rule on page 5, AMERICAN MACHINIST, for Sept. 20th, 1879, is probably as plain, simple and accurate as possible, as it gives the conditions necessary to make a rough estimate of the horse-power of steam engines. Another point in calculating the power of steam engines, which is not quite as well understood as it might be, is, that the average pressure is often confounded with the mean effective pressure, and "vice-versa," whereas, in fact, the average pressure is the pressure exerted against the piston during the whole length of the stroke, regardless of the back pressure and the resistance of the atmosphere, while the mean effective pressure represents the difference between the two. The piston of a steam engine is exposed to two forces—that due to the incoming steam on one side, and the resistance resulting from the exhaust and the atmospheric pressure on the other, and the difference between the two, or that portion of the pressure that is utilized or converted into work, represents the mean effective pressure.

STEPHEN ROPER.

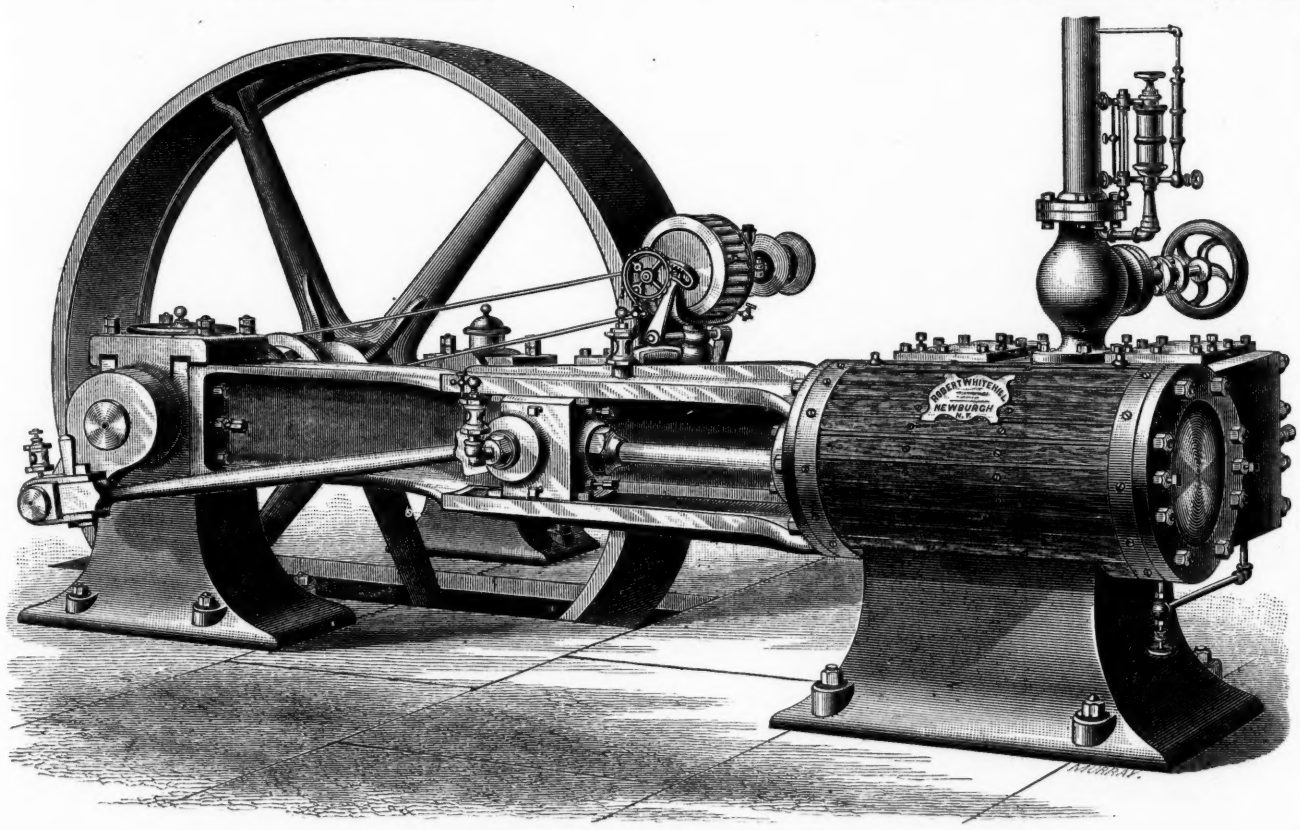
working with a mean pressure in the steam chest of sixty pounds; now, if the valve be properly constructed (for compression by inside lap), the exhaust—having been wide open, allowing all the steam above the atmospheric pressure to escape, will close about three inches before the piston reaches the end of the stroke. In traveling the next one and a half ($1\frac{1}{2}$") inches, the piston will have compressed the imprisoned vapor to one-half its volume, and increased its pressure to one atmosphere pressure; and in traveling the next three-quarters of an inch, again reducing its volume one-half, and increasing the pressure to two atmospheres; and in traveling the next three-eighths ($\frac{3}{8}$ in.) of an inch, again reduces the volume one-half, and increases the pressure to four atmospheres. The reader will perceive at once that the gradual increase of pressure by compression will have arrested or overcome the inertia of the piston and taken up the lost motion referred to, and when direct steam is admitted, it will find the ports and clearance already filled and the piston in motion, and the engineer will discover that no reasonable lost motion will produce sound or thump.

time of application, is a fact beyond *all* dispute. All truth is valuable, and that truth which brings to light *all* the hidden actions within the steam cylinder is of inestimable value to the advancement of steam engineering; and the information given by the indicator points to improvements beyond the proportioning and setting of valves, the dimensions of passages, and the production and management of steam.

The indicator has more to do with the connecting rod, crank disk and bed plate, or even the foundations themselves, than Mr. Roper seems inclined to give it credit for. I will give an example of that kind. The writer once examined an engine 23" diam. cyl. × 22" stroke with an indicator. The engine had been pounding all its life. The old foundations had been renewed, the crank shaft had been taken out and "turned up;" then it was thrown out, and a new crank shaft and disk replaced; and yet it went on "pounding," as before. Skilled mechanics had used all their talent on it in vain. New valves had been put in, two of which were equilibriums, and, if a short cut-off were used, the engine would actually pound her foundations down. The matter had been given up in despair. But it was only necessary to apply this silent informer one moment, and the fault was revealed that had baffled so many men so many years. Without tightening a bearing, the engine was made to run smoothly at once, notwithstanding that a great deal closer cut-off was used. The fault was with the steam. Not its management, but nature. The indicator did not cure the steam, but, by indicating its nature, pointed to the management required to bring about the results desired in making the engine run smoothly; and, at the same time, to use that degree of expansion which was most economical under the situation. Again: the writer was called upon to conduct duty tests on a fine pair of Worthington Compound Condensing Duplex Pumping Engines. The steam cylinders were 14" H. P. cylinders, and 24" L. P. cylinders, pumps 10" diam., and 18" stroke. They were working in a mine under a lift of 400', and were about 500' away from their boilers. One of the objects of the test was to ascertain the loss from condensation in the steam pipe" which was 5" diam., and 'protected by fire clay. The test was conducted as follows: Coal weighed to boilers, water measured to boilers, steam kept at 75 pounds at boilers, water level not allowed to vary but slightly, engines run at a uniform speed of 52 strokes per minute, vacuum noted every fifteen minutes, and the engines were indicated occasionally and the length of stroke noted carefully. On the morning of the first day's trial, the cards taken showed that the engines were not evaporating as much as they should in the L. P. cylinder. This deficiency may have occurred from one of two causes—either too wet or too dry steam. It was very improbable that the latter should be the case, so a trap and collecting drum were added to the steam pipes just above the engines, and the trap was noticed to discharge a great deal of water. After this improvement was added, another test was made, and the cards from the L. P. cylinder were shown to be considerably increased in size while those of the H. P. cylinder were proportionately decreased; and as the H. P. cylinder measures the steam used by the engines, they were shown to be using less steam for the same work. The vacuum was 3" better, and the engines worked more smoothly. In fact the duty was increased about 2,000,000, in which the indicator and measurements and weights agreed. The loss from condensation was found to be 48%. How was this loss ascertained? The indicator measured the steam discharged into the condenser, and we were able to measure the feed water by ordinary means—the difference was the loss. The cards showed also that there was a great deal more steam discharged from the L. P. cylinder than was discharged into it by the H. P. cylinder; also that the L. P. cylinder discharged more heat than it received from its H. P. cylinder. These revelations (using the language of Porter) "are calculated to set engineers to thinking," and unless you want to think, I would not advise the use of the indicator.

Respectfully,

LEADVILLE, Col. ED. F. WILLIAMS.



WHITEHILL'S IMPROVED STEAM ENGINE.

Whitehill's Improved Steam Engine.

Our illustration represents an improved stationary steam engine, the general appearance of which does not require description, but will be readily understood from the illustration. The valve motion will bear a close consideration, as it possesses some peculiar features. It seems to be a settled fact that the most durable form of valve to resist wear and avoid leaks, is the plain slide valve.

The valve motion of this engine consists of three valves, viz.: the main valve, the cut-off valve and the "gridiron" or governor valve. The main valve is the same as the ordinary slide valve, with the exception of being cored out at each end for the steam ports, and regulates the admission and exhaust, and can be adjusted independently of the other valves. The cut-off or intermediate valve slides on the back of the main valve, and is provided with a number of ports which are controlled by the governor valve. The main and intermediate valves are driven by eccentrics in the usual manner, the intermediate having a motion coincident with the piston. The governor valves are of the gridiron pattern, and consist of two valves, which are connected with the two arms of a lever of the first order, by means of links. This lever is attached to a stem, which forms the fulcrum, which passes through the steam chest cover and is fitted with a stuffing box. On the end of this stem is a lever, which is connected, by means of a lever, to a similar lever on the governor, through which motion is communicated from the governor to the valves. When the engine is at rest the cut-off has no effect; therefore, it can be started at any point of the stroke; but, as the speed of the engine increases, the action of the governor will thrust the valves apart and effect a cut-off, or closure, of the steam ports in the intermediate valve at an earlier period of the stroke. If the speed of the governor is decreased, the governor valves are brought closer together, and steam is admitted to the piston for a longer portion of the stroke. By this arrangement, the inventor claims to have attained all the advantages of some of the more intricate devices for an automatic cut-off, regularity of speed, economy in the use of steam, etc.

These engines are built by Robert Whitehill, of Newburgh, New York.

Letters from Practical Men.

Editor of American Machinist:

DEAR SIR:—After very carefully reading nearly four columns in your issue of the 15th inst., over the signature of Mr. Chas. A. Hague, I am unable to decide whether or not he is in favor of compression.

Should you afford space for my composition, the reader will not be so unfortunate as I have been, for I will state that I am in favor of compression, and for the following reasons, which have been entirely overlooked by your several contributors to the subject, and not for any of the reasons given by them.

Neither direct nor compressed steam is necessary to arrest the inertia of the moving parts, to wit: the piston, rod, and connecting rod, for this expends itself in useful thrust against the crank pin, forcing it to the dead center; now if there be no inside lap on the valve there will be no compression, and the incoming steam will instantly set the piston in motion towards the other center, and the lost motion in the main journal, cross-head and crank-pin, in being instantly taken up, gives a sharp knock or thump, to avoid which the engineer will be constantly keying up, causing the journals to heat and wear rapidly.

That the elementary reader may more readily understand what is meant by compression, I will suppose a simple twelve by twenty-four-inch saw mill engine, with slide valve with large ports and free exhaust, and

In constructing a valve, care must be taken that compression be not carried beyond the pressure maintained in the steam chest.

WM. GOLDING.

NEW ORLEANS, La.

Editor American Machinist:

I see an article in your very excellent paper, written by Stephen Roper, concerning the steam engine indicator, in which he attempts to depreciate that valuable instrument. Now, Mr. Editor, the indicator has led me through a great many dark points, in engineering matters, to the true light, and I now feel that it is as essential to the engineer as the rule or calipers are to the machinist. It brings to light the hidden things within the steam cylinder; it determines whether your steam is wet or dry, whether the piston speed is fast enough. By a line as easily interpreted as the figures on a scale, it shows the amount of back pressure throughout the stroke. In fact, it reveals, in unmistakable and strictly truthful characters, the workings of the valves and passages in all their varied functions. Such a library of information as is condensed into the indicator diagram should be, and is, regarded, by every thorough engineer, as precious and indispensable to the science of engineering, as the knowledge we have of the properties of steam and the mechanical equivalent of heat, or the laws of virtual velocities. That the lines drawn by the indicator, when skilfully applied to the steam cylinder, are true representatives of the pressures within, at the

The Rockland, Me., shoe factory will soon start up again.

Birdsall's Steam Piston.

The accompanying cuts represent a new and practical arrangement in the construction of pistons for steam engines, steam pumps, and other engine machinery using reciprocating pistons which require easy and ready adjustment, to prevent leakage and compensate for wear. Fig. 1 represents the piston with the follower, Fig. 4, removed, showing the construction and means used for expanding the packing rings, which device consists of three cast iron segmental plates, bearing only at each end, and with one end of each abutting against the lugs which receive the follower screws, and each one of such a length as to equally divide the points of contact on the inner ring. The body of the piston and hub are cast in one piece, and secured to the piston rod in the ordinary way, and the hub turned off true to receive the collar shown in Fig. 2, which collar is bored out sufficiently large to admit of a brass, or composition bushing, to prevent the collar from becoming rusted or corroded, so as not to turn freely on the hub. With the segmental plates in position, the collar is put in place and connected with the plates by pieces set at such an angle with a radial line, that when the collar is moved in a direction to tighten the parts (the plates being held in position by the lugs to which the follower

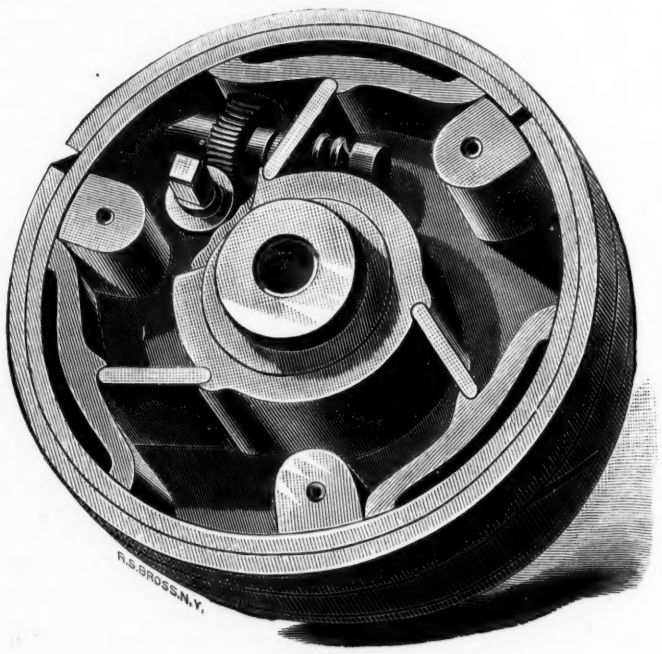


FIG. 1.

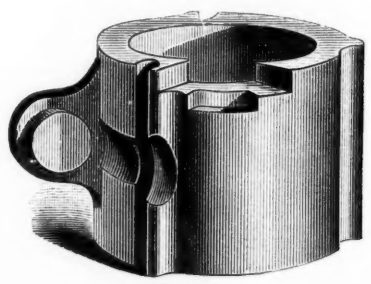


FIG. 2.

FIG. 3.

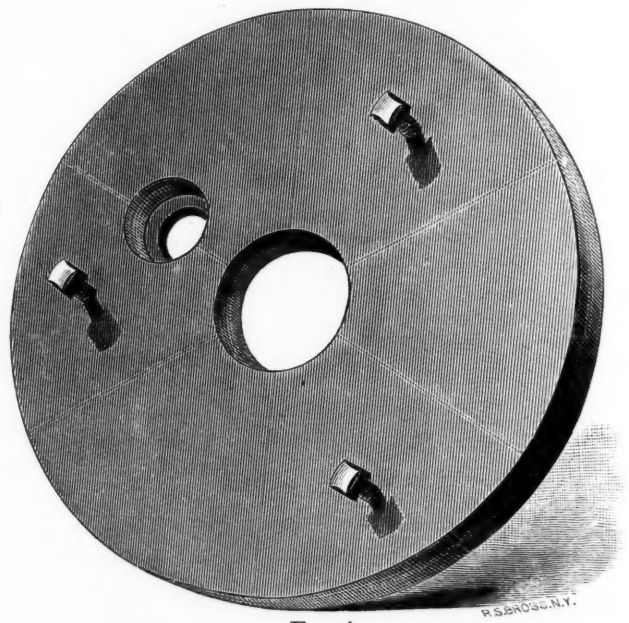


FIG. 4.

is secured) will cause a uniform expansion of the rings. A worm wheel and screw (made of brass to avoid corrosion) are employed to operate a screw, which the worm wheel (held between jaws and acting as a nut) forces out. A steel coil spring is interposed between the end of this screw, and a lug on the side of the collar, which is plainly shown in Fig. 1, the effect of which is to provide for the wear, and compensate for any inequalities in the cylinder. The screw which operates the worm wheel is provided with a square head, which extends through the follower plate sufficiently far to apply a socket wrench shown in Fig. 3. The opening provided for the wrench is made steam tight by a screw plug. The convenience of adjustment (which only requires removal of the cylinder head), and the precision and certainty with which every part is made to operate, it is believed will be regarded as a valuable improvement. For further particulars, address, E. M. Birdsall & Co., Penn Yan, New York.

Gun barrels of superior quality are made out of the stub iron obtained from old horseshoe nails. The stubs, after having been freed from all rust and dirt by being brightened in a tumbling box, are combined with from 12 to 50 per cent. of steel in blocks of the same size as the stubs. The combined metals are puddled, hammered, heated, tilted, and rolled into ribbons, to be wound in coils around mandrels, heated to a welding heat, jumped, and finished by a hammer on the anvil.

Mechanical Terms.

Editor American Machinist:

SIR.—The object of addressing you on the subject of Mechanical Terms is a desire to reveal some obscurities in which the science of mechanics is involved.

Not having had the advantage of college education, but having, from my early youth, been engaged in mechanical pursuits, and having studied the science of the same during my leisure hours, and encountered many difficulties in mastering the subject, for want of definite use of mechanical terms in text books, some eight years ago, I got hold of Rankine's Manual of the Steam Engine, and expected to be in possession of something tangible on the subject of mechanics. I studied the same, but with discouragement, for it impressed me with the idea that the science of mechanics is too profound for my comprehension. I have since learned what I now believe to be the true principles of mechanics, which are, indeed, very simple and applicable with certainty in all mechanical pursuits.

The dynamical branch of mechanics consists of the following simple principles:

Elements.	*Functions.*
Force,	Power,
Velocity,	Space,
Time.	Work.

Force is any action that can be expressed simply by weight.

Velocity is rate of motion in regard to assumed fixed objects.

Time is duration, or that measured by a clock.

Power is the product of the first and second elements, force and velocity.

Space is the product of the second and third elements, velocity and time.

Work is the product of the three elements, force, velocity and time.

All dynamical problems, without exception, can be solved with above six principles.

After having learned and used these principles in my mechanical pursuits, I am able to understand Rankine; namely, that his manual of the steam engine is all confusion, as far as regards the use of mechanical terms.

The term most used in Rankine's work is "energy," with various adjectives, and defined as follows, on page 32: "Energy means capacity for performing work, and is expressed, like work, by the product of a force into a space."

Capacity for performing work is power, or the product of force and velocity, which is an entirely different function from that of work, which is the product of force and space. Rankine does, therefore, not use the term energy for the purpose he has defined it. On the same page he says:

"The energy of an effort, sometimes called potential energy, is the product of the effort into the distance through which it is capable of acting."

By the term "effort," Rankine means force, but there exists no energy without force, and his definition of potential energy is substantially the same as that for plain energy, and only given in different words.

By simply changing the phraseology, Prof. Rankine defines a great variety of energies, all of which mean simply work, or the product of force and space; namely:

Rankine's Energies.	*Translation.*
Plain energy,	Power,
Potential energy,	Powerful power,
Intrinsic energy,	Genuine or true pow'r
Kinetic energy,	Motive power,
Internal energy,	Inside power,
External energy,	Outside power,
Equality of energy,	Alike power,
Factors of energy,	Terms of power,
Energy exerted,	Power that pushes,
Actual energy,	Real power,
Mechanical energy.	Power in mechanics.

All these terms of energy mean simply power, but Rankine uses them at random to denote work, without regard to his definitions, and sometimes he makes different definitions of the same term for temporary use.

On page 33 (Manual of the Steam Engine) he says: "The energy exerted in producing acceleration is equal to the work of acceleration."

On page 40 he says: "The power of a machine is the energy exerted." "The effect is equal to the power multiplied by the efficiency," and "the effect the useful work performed in some interval of time of definite length."

Page 39: "The efficiency of a machine is the product of the efficiency of the series of moving pieces, which transmit energy from the driving point to the working point."

Page 30: "Effort is a name applied to a force which acts on a body in the direction of motion." This definition is only for his temporary use.

The advantage or disadvantage (depending upon judgment) of Rankine's nomenclature is that either term can be used for any one of the others; and it is very convenient for writers of mechanics, who do not understand the subject, but stick in these terms here and there, for they fit everywhere. The terms can be used at random with safety and make the writings sound very profound; of course the readers will not understand it, but fully appreciate the profoundness of the author. (See "Correlation of Vital and Physical Forces," published by Van Nostrand.) I have often read articles of this kind which sound much like those of Spiritualism.

Within the last few years there have been published, in this country, a number of works on mechanics, written by professors of institutions of learning, flourishing with Rankine's nomenclature, which make their works of little or no value, but a burden upon the students, who are thereby required to tax their time and mind to no practical purpose.

A few years ago, a perpetual motion was exhibited at No. 705 Sansom street, Philadelphia, and its inventor explained the machine to be operated with all the Rankine's energies as fluently as a professor of mechanics would do it. The machine appeared to be operated by weights pulling on levers, and lifted by the same machine, but the fact was that the motive power was concealed under the bedplate.

The Rankine nomenclature is thus extensively used by humbugs for delusion. The best definition of energy that I know of is that given by the actuary of the Franklin Institute, Mr. D. S. Holman, namely: "*Energy* is the activity or vigor of man or animals in accomplishing an undertaking or purpose. The term is often applied to steam and machinery, but should be used only for that power which is governed by the mind."

I accept Mr. Holman's definition of energy.

W. BARNET LE VAN.

3607 Baring street,
Philadelphia.

The N. Y. Daily Times says: The saving in time and expense brought about by uniformity in manufactured articles is so obvious that it is hard to understand why it was never made a practice in manufucture until comparatively recent times. A short time ago a discussion arose as to whom the credit was due for the introduction of this method into the manufacture of arms for our Government, and though we do not know that this particular dispute has been satisfactorily settled, the unquestioned fact remains that for many years after our Government was organized the guns and other military equipments it had made, or made for itself, were never of the same exact pattern, and hence the breakage of any part could only be remedied by having an entirely new piece specially constructed to take the place of the old one. What was true of the Government system was also true of the plan used for making articles for household and business purposes.

To the Editor of the American Machinist:

SIR—The article by Mr. Roper, in your issue of November 8th, is avowedly intended to draw out the "Champions of the Indicator." I find it difficult to believe that it expresses his real—it certainly does not express his matured—convictions. I wish merely to call attention to the illustration it presents of what may be styled the Darwinian mode of reasoning, which, by an ingenious presentation of exceptional or abnormal cases, affects to prove the exact opposite of the truth.

While the country swarms with engines in which, by means of small pipes and contracted ports and passages and insufficient valve movements, from one-half to three-fourths of the boiler pressure is lost to the cylinder, and then from a quarter to half the power the engine does exert is wasted in expelling the exhaust—all from utter ignorance on the part of builders of what the indicator, and that alone, will teach anybody who will intelligently use it—Mr. Roper finds a case of an engine built correctly in these respects by

two young men who never had seen an indicator, but who obviously must have got their knowledge of areas from somebody who had, and claims to have proved the indicator to be useless.

Very respectfully yours,
CHARLES T. PORTER.

Turbine Water Wheels.

BY SAMUEL S. WEBBER, C. E.

No. II.

This matter of "testing" water wheels is something that has interested the builders and buyers of wheels to a great extent during the past ten years, and an accurate test s of great value; but, unfortunately, owing to the publication of tests that were not made with the necessary care, and under the proper conditions, many persons have become skeptical as to the whole thing and denounce tests in general. Then there are others who, not knowing the exact manner of making a test, or the calculations involved, think there are some very mysterious things about the whole affair that only the engineer and his assistant are conversant with, and the results are brought out just as they choose to have them. Now I, for one, have failed to see anything about a test that is not perfectly simple and capable of being understood by persons of ordinary intelligence. Of course, if the expert and his assistant are not honorable men, and are willing to sacrifice their reputations for some personal gain, and do not give the facts as they are. Why, I say such men ought to be exposed, and any such test is not worth shucks.

But I don't KNOW of any tests of this sort having been made, and where inaccuracies have been found in the results of tests made, at different times, of the same wheel. The differences can, in most cases, be traced to the difference in setting the wheel, or leakage, or some want of care in setting the gauges and reading them. But, to show how simple a test is, and, at the same time, how much care must be taken to observe the conditions, I will give a sample test, showing the necessary calculations and what conditions, in setting and adjusting the apparatus, must be strictly followed.

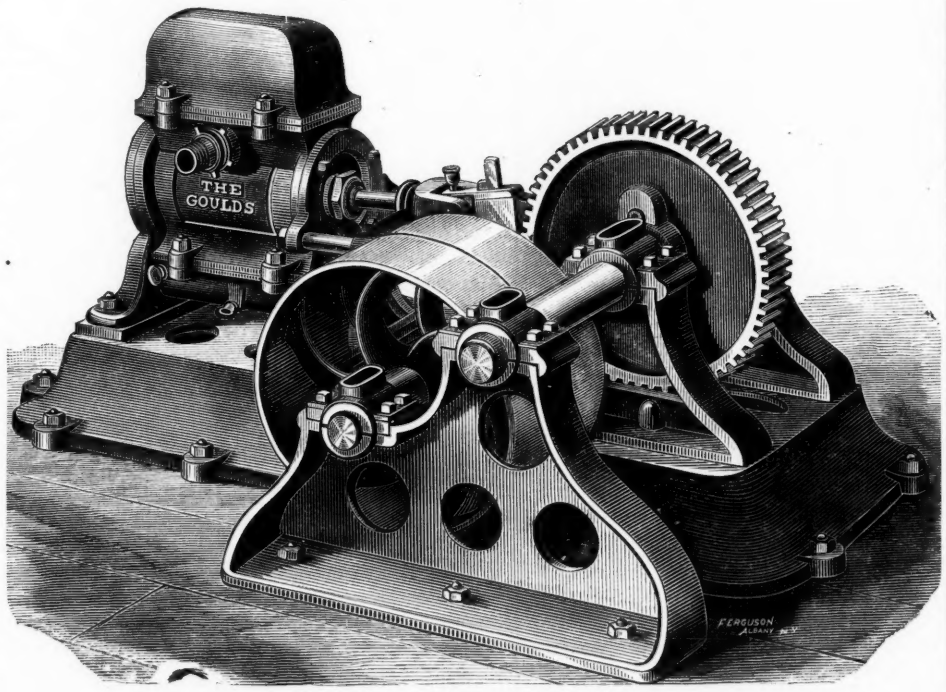
The measurement of the water flowing through the wheel is obtained by constructing a weir across the end of a tight tail race, or flume, which should be wide and deep enough to allow the water to become quiet and find a level after its rapid passage through the wheel, and, in such cases where the nature of the surroundings will not permit of this, a fine rack, or strainer, reaching to the bottom of the race, and fine enough to set the water back slightly, should be put in across the flume. This will even the flow beyond and break up any currents. This rack must be, at least, 15, and better 20, feet back from the weir. The construction of the weir is the next step, and may be of any length, but I prefer, at least, 8 feet, and, for any wheel over 30 in. under 20 ft. head, 9 or 10 feet is better; and the larger wheels require a weir long in proportion. It is usually made of plank, and the edge over which the water flows must be true and level, and the sides also true and at right angles to the top, or crest. The up-stream edges must be sharp and smooth, and the down-stream edges beveled off, so the water will only come in contact with sharp up-stream edges; then, from the bottom of the race to the top, or crest, of weir, the height must be, at least, three times the depth of water that will flow over. A weir one foot deep should be two feet shorter than the width of tail race, or else the full width, as, in one case, a deduction must be made, in the calculation, from the length of the weir, for end contraction, in the flow of water; and, in the other, none, as the weir, being full width, there is no end contraction. Also, the water below, or outside, should not be within a foot of the crest of weir, so it shall not impede the flow-over. And, lastly, in taking the height of water on weir, it should be measured at a point far enough back or up stream to be above the curvature of the surface occasioned by the fall in height, as the water approaches the weir with increasing velocity, and this measuring point should not be more than one-third the length of weir back. The Hook gauge, for taking this measurement, should be located at this point, or else, if placed below the weir, in a can, or vessel, this latter must be connected by a straight pipe, that has its up-stream end opening at the point mentioned. This will insure a correct reading of the head on weir.

I have gone into somewhat minute detail on the matter of weir construction, but I can only say that, on the observance of these details, the accuracy of the results depend, and I will not, at this time, undertake to give the whys and wherefores, as it would be somewhat tedious. The "Lowell Hydraulic Experiments," by Jas. B. Francis, C. E., contain the entire story for such as wish to go to the bottom of the matter.

The formula given by Mr. Francis for determining the flow in cubic feet, which is the only one based on accurate experiment, and universally used, is as follows:

$$Q=3.33(L-0.1nh)h^{\frac{3}{2}}$$

Q=number of cubic feet per second.
L=length of weir in feet.
h=depth of water flowing over in feet.
n=number of end contractions.



NEW DOUBLE-ACTING FORCE PUMP.

As, probably, some of the readers of the AMERICAN MACHINIST don't want to have to bother with formulæ, I will, after describing the friction brake and weighing apparatus, work out the entire calculation in plain figures, showing the application of formula given.

To get the power developed by the wheel is the next point I propose to consider, and is ascertained as follows, though I will first give some points to be observed in setting the wheel. The flume, or penstock, may be of wood or iron, securely braced, and tight in all the joints, and should have a firm, rigid foundation or platform, upon which the wheel is to be set. In setting the wheel, it should fit its case easily, so as not to bind when the weight of water is on it, and should be tight in the gate and stuffing box, so no leakage will take place, as no deductions should be allowed to a wheel for leaky gates, as the water leaking through becomes effective when the gates are opened. But if there be any leakage through the flume, or at the joint of the wheel case and floor of the penstock, this leakage, if flowing over the weir, may first be measured with the gauge and deducted from the whole when the wheel is running, as it is only the water actually acting on the wheel that should be charged to it. Having got everything tight and the wheel to turn easily in its bearings, we key on to the shaft a friction pulley with a smooth, accurately turned face and perfectly balanced. The diameter should be about 3 feet by 12"—face for small wheels, say not over 30 inches, while a larger one is required for wheels of greater power. I prefer to have the prony brake made in halves, of metal lined with blocks of hard wood, and to enclose the entire pulley, except a narrow opening of a couple of inches, to allow for tightening up. The surface of the wooden blocks should be grooved or "herring-boned," to distribute the lubricating water, which I have found to be better than anything else when rendered a little greasy by dissolving soft soap in it. By having holes in the brake leading to the grooves, the soapy water can be made to give a perfectly even, regular friction at all speeds, while oil is likely to heat and gum, and give a deal of trouble, and, even if mixed with water, it is not nearly so good as soap. Attached to the brake casting is an arm or lever, at the further end of which is an eye bolt with a knife edge, to which the scale beam of the weighing apparatus is attached. The distance from the center of wheel shaft or pulley to the knife edge in the brake lever is the radius of a circle, whose circumference is the distance, in feet, the weight lifted is supposed to travel at each turn of the wheel.

The scale beam is either of metal, and graduated to pounds, or is provided with a weight pan, hanging from the end, the weights being, in all cases, multiplied by the leverage used for the total effective weight lifted. To prevent jar and vibration, there should be a rod and piston attached to the opposite end of the scale beam from the weights, which works loosely in a cylinder or dash-pot filled with water. This arrangement, while allowing the lever to work very easily, prevents any rattling or jarring, and the weight of the rod and piston, after being put in the dash-pot, should be counter-balanced by hanging an equal weight on the weight end of scale beam. This completes the weighing apparatus, and, with a speed counter fastened to the wheel shaft, to register the times per minute, we are about ready to begin.

Under the authority given the Census officers, a number of experts have already been appointed, and others will be named in time for the work in 1880. A number of persons are already in the field obtaining statistics of gold, silver, iron and copper mining. Others are obtaining statistics of steam and water power, and manufacturing machinery. Special investigators have been at work on the social statistics of cities and penal and reformatory institutions. Building stones and the quarrying industry will form the subject of separate investigation by one of the most eminent geologists of the country, while the statistics of tree covering, forest wealth and the timber industry will be collected by an expert equally eminent in his own field. The report on the cultivation of cotton will include investigations made on his own account by a specialist who has devoted years to that subject, and the report will be the standard authority for the world.

It is proposed that freight cars all over the United States shall be built upon the same pattern, having interchangeable parts. If this is done the master mechanic of the Erie will be able to tell at a glance whether the charges for repairs upon freight cars, in the bill sent to him by the Kansas Pacific Railroad Company, are reasonable or extortionary, an amount of knowledge which is at present denied to him. This reform has been earnestly pressed, and in all probability will soon be carried out.

The other day one of the largest steamers in the transatlantic trade, drawing twenty-four feet and seven inches of water, passed safely in through Eads' Jetties at the mouth of the Mississippi. Now comes the news that the Ashburne has gone out with the largest cargo of cotton ever shipped from New-Orleans on a single vessel.

New Horizontal Double-Acting Force Pump.

It would seem that inventive genius had, ere this, devised every style of pump that could be conceived, but now comes to the front the enterprising Goulds Manufacturing Co., of Seneca Falls, N. Y., with a new and original pumping machine, designated as the Patent Horizontal Double-Acting "Challenge" Force Pump, on iron frame, geared. A glance at the cut gives an impression of a substantial and durable piece of mechanism. Its working parts are all brass. The cylinder is brass lined, and, by unscrewing the brass nuts at the side, both the lower valves are accessible without disconnecting either the suction or discharge pipes. In fact, the important part that brass plays in the construction of this pump warrants the brazen assurance that it has every possible qualification essential to commend it. It has brass poppet valves and steel piston rods, brass cased.

The gears are cut, and are 6 inches and 16 inches diameter respectively. The relative sizes of these gears could be changed, if desired, arranging them so as to work against a very heavy pressure, or to run faster, against lighter pressure. The connecting rod has strap joints with gib and key, and with brass boxes. The cross-head runs on two substantial guides, thereby taking all the lateral pressure off the stuffing box and piston, and, at the same time, forms a brace from the pump-cylinder to the pillow-blocks.

The pulleys are 18 inches diameter and 5 inches face, and have an outside bearing (as shown in cut). The frame is all cast iron (weighing over 700 lbs.), very heavy and strong, occupying a space 5 feet long by 2 feet 3 inches wide—at the pulleys 3 feet 3 inches wide. The whole pump weighs about 1,000 lbs., so it will be seen that it is capable of doing good service, and continuously. The pulleys could be run at from 120 to 160 revolutions, which would give 90 to 120 strokes of pump respectively. For continued work the less speed is the best for the economical working of the pump. When used for fire protection, it could be run at the higher rate of speed.

Two sizes are made, varying, by a half-inch, in the diameters of suction and discharge pipes.

New Orleans is carpeting its river front with mats of cane bound with wire, to prevent the Father of Waters from washing its shores away. These mats are a foot and a half thick, 25 feet wide, and 200 feet long, one end being fastened to piles driven in the river bank, and the other laid upon the river bottom, where it is anchored by sand bags. The mats are made by machinery, and it is the intention to cover 8,000 yards of the river front with them.

A fire in Meriden, Conn., damaged the Malleable Iron Works $20,000.

Strength of Boilers.

BY V. HOOK.

The pressure in a steam boiler or other containing vessel tends to force the same into a circular form, if it does not possess that form; and if it does, the pressure has a tendency to sustain it in that form. Hence, the strongest form for a boiler is a circle, and any departure from that shape makes itself manifest by the necessity of stays. While the pressure acts from the center radially, out to the circumference on an indefinite number of radial lines, the mathematics of the strength of the shell supposes that the pressure acts as the arrows *a, a, a, a,* in Fig. 2, that is tending to lift the top from the bottom. In Fig. 1 the pressure represented by arrow *a* is resisted by arrow *a′*, and similarly arrow *b* and *b′* resist each other, and as each are equal, we may assume any one direction as that in which the pressure acts, as *a,a,a,a,* in Fig. 2, tending to part the boiler through the line *b, b*. We might, as stated above, assume any other direction of the pressure, but as the shell is as strong through *b,b* as it is through any other similar section, the strength as ascertained at *b,b* will be the strength of the boiler. The standard of comparison between different brands of boiler iron is based on the strength of a *square* bar of that iron, the sides of which are one inch in length, and a section through the bar representing one *square* inch. The tensile strength of such a bar will average 50,000 lbs. Assuming, then, that the pressure tends to tear the top from the bottom of the shell, it is apparent that the force acting to do this is represented by the length of the shell in inches, multiplied by the diameter in inches, and by the pressure per square inch. The iron being the same thickness throughout the shell, we will also assume that a section one inch in length of the boiler is a *facsimile* as to strength of any other section of similar length. The iron being 5-16 of an inch thick and one inch (assumed) in length, it is plain that its strength is but 5-16 of our standard of comparison 50,000 (or 15,625 lbs.) Now, as we have *two* sides of the boiler of 5-16 thick, we must double the above amount which = 31,250 lbs. as the strength of our section if it were without a joint. The strength of a single riveted seam (Fig. 3) has been ascertained to be but 56% of the solid iron, and hence we must take that percentage of 31,250 to arrive at the strength of the weakest portion, which, of course, comes under the principle that the strength of any structure is equal only to its weakest part, 56% of 31,250=17,500, which is the product of the length of our section (1 in) × by the diameter, say 48 in., multiplied by the pressure per square inch necessary to burst the boiler. We have, therefore, to find the pressure per square inch necessary to burst the boiler, only to divide 17,500 by the diameter (the length being 1 inch or unity). This gives us nearly 365ths, which, divided again by our factor of safety, we will take as 6 (or the working pressure = to 1-6 the bursting pressure), and we obtain 60 nearly, as the proper working pressure, all of which tends to show that there are few locomotives in the U. S. that are not carrying more pressure than they ought to, or would be allowed to, if there was a law regulating the same.

The strength of a joint, like Fig. 3, through the rivet holes, may be found by taking the length *a*, less the diameter of one hole multiplied by the number of holes. This leaves the length of solid iron between the holes, which, multiplied by the thickness and by the strength of a sectional inch, and from 15% to 20% deducted from the result, for injury done the iron by the punch, leaves the probable strength of metal between the holes. A staggered or double-riveted joint, shown in Fig. 63, has 70 per cent. of the strength of the solid sheet, as ascertained by Fairbairn's experiments. From inspection, it will be seen that there is as much metal between the holes *h,c* and *h, f* as there is between *c, f*. The metal between the holes is much greater than in Fig. 3, while the number of rivets is in proportion to the metal left between the holes, and hence the strength of the joint may be deducted from the metal left between the holes on a line, *a, b*. The strength of a rivet, to resist shearing, is about 50,000 lbs. per square inch, hence the sectional area of one rivet, multiplied by the number of rivets, and again multiplied by 50,000, will closely approximate their shearing or detensive strength. The rivet area strength should be kept as nearly equal as possible to the strength of sheet between the holes. The strength of the sheet to resist crushing is represented by Fig. 4. It is plain that if the rivet does not shear, nor the sheet rupture between the holes, the part *a* must be pushed or sheared out of the way, if rupture takes place. The resistance which the part or piece, *a*, offers is represented by the area *b, b*, or the length *d*, by the thickness of the plate

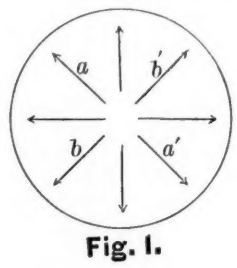


Fig. 1.

plus the equal area, *c,c*, and the whole multiplied by the detensive strength of the sheet, which is about 50,000 lbs. per square inch. In designing a joint, the piece *a*, Fig. 4, the shearing strength of the rivets and the strength between the holes should be as nearly equal as possible, to make as strong a joint as is possible. The joint shown in Fig. 8 has a welt piece, *a*, added, and is much used in locomotive work. It does not add as much strength as is commonly accredited to it.

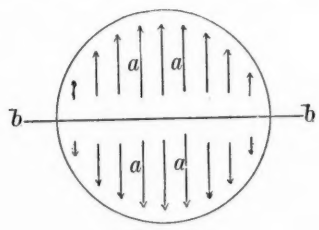


Fig. 2.

The line of rivets *d* and *f*, Fig. 5, are commonly spaced twice as far as the middle one *e*, and therefore present only half the shearing strength of rivets that line *e* does, and hence if rupture were to take place it would occur first through either *d* or *f*, if it were not for the stronger joint *e*. Therefore, after the internal pressure exceeds the strength of joint *d* or *f*, they are no longer of use, as rupture is alone prevented by the superior strength of the joint *e*. The welt strengthens the joint simply because it puts the rivet *g* Fig.

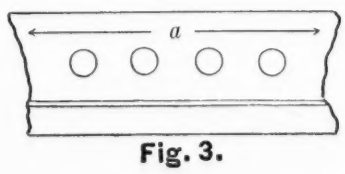
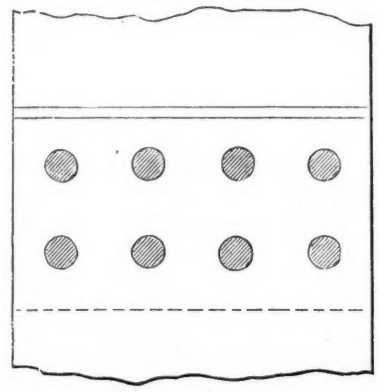


Fig. 3.

8, into double shear, that is, the rivet must be sheared through the line *h* and *i*, and therefore presents double resistance. The part of the plate in front of the rivet must be proportionally increased to meet the increased resistance, and the pitch of the holes increased as much as possible and still retain a tight joint. A combination of this joint and the staggered riveted joint would make the strongest possible longitudinal joint, as it would give the greatest amount of metal between the holes, and also present the rivet in double sheet. Fig. 6 shows a mode of making a joint by which the strength might be made equal to that of the solid sheet. The distance between the holes, by making the joint long enough, might be made equal to the width of the sheet, or in excess of it, for injury done in punching. The joint shown in Fig. 62 is not strengthened by the second row of rivets, barring the grip due to contraction of the extra rivets, as the strength of metal between either row is the same, as is also the number of rivets, etc.; and the joint is as weak through one row of rivets as the other. I have been considering the longitudinal strength only. The transverse strength of a boiler is that which prevents one end from being torn from the other. This strength is represented by the thickness of the iron × by the circumference × by the strength of a sectional inch, and the whole less the percentage of loss due to the kind of joint. However, a single rivet joint will suffice, generally, as the boiler is about twice as strong transversely as longitudinally.

Persons buying boilers would do well to have samples of the iron, from which the boiler is to be built, tested for tensile strength, and take no interested parties' word, or bond, either, on that point. An actual test settles the matter beyond doubt. All holes should be drilled and rounded in the inner edge, as shown at *a, a, a, a*, Fig. 7, as a drilled hole, if not rounded, will shear the rivet sooner than a punched hole. Flat surfaces should be stayed to from six to ten times the pressure they are to resist. The *area* of rivets holding crow feet to boiler heads, etc., should be equal to the stay coupled to said crow foot. It is a good plan to make stays coupled to crow feet

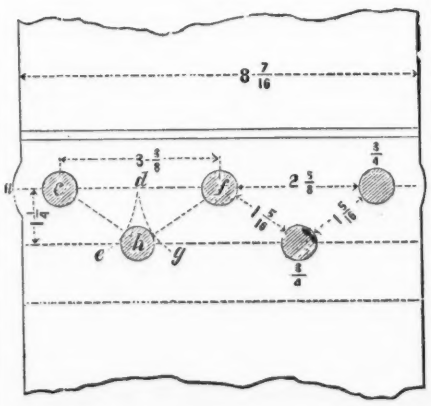
Fig. 62



slightly shorter than the required length. Expand them by heat, and, on cooling, they will all be found tight and necessarily bearing their proportional strain. It is a *bad* plan to collect one end of stays (such as crown sheet stays when stayed to shell) into a smaller area than the other, as it is plain to be seen that the smaller area must resist more than its share in proportion as its area is smaller.

Some German and Russian rail-mills employed an ingenious method to overcome the difficulty in cutting red or nearly white hot rails, so that they may be all the same length when cold. The rails are looked at through a dark glass; when they have cooled to a certain temperature they cannot be perceived. If a dark blue or orange-yellow glass is used, the rails may still be at a red glow, but the light radiated from them does not reach the eye. It may be considered that the light from two rails observed through the same

Fig. 63.



dark glass disappears at the same temperature, and thus a rule is obtained for cutting the rails to the same gauge. Each rail is allowed to cool till it can no longer be seen through the dark glass, and is then cut. The result is said to be satisfactory.

It is estimated that one-third of all the paper used in the world is now made in the United States.

Compressed Air.

No. III.

BY JOHN FISH, M. E.

In the designing and building of air compressors, it is absolutely necessary that we should give a sufficiently large margin of strength to the different parts, so that should the machine be called upon (as is often the case) to supply air of an increased pressure, that we should be able to do so without straining the machine too much.

A lack of stiffness or strength has shown itself very markedly in a number of cases in our mining regions, when air compressors were first brought in use, for driving rock drills, steam pumps, and ventilating mines. The workmanship should be of the very best character, not only on account of its adding to the lasting quality of the machine, but also that the joints, stuffing-boxes, valves and piston-rings, in fact, all the parts which hold or control the air under pressure, should be fitted with the greatest accuracy, and be made extra strong, so that the greatest

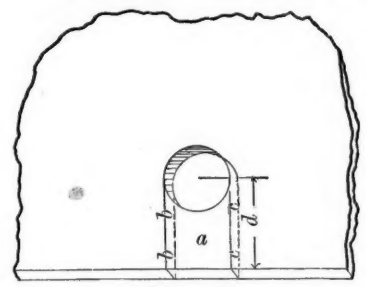


Fig. 4.

amount of efficiency should be obtained from the power in compressing the air.

As yet there seems to be a diversity of opinion among manufacturers as to the best arrangement of machine for accomplishing the end in view. The earliest made in Europe, for any real practical purpose, were horizontal, and made with a straight plunger, working into two separate pump barrels, packed with ring stuffing-boxes on the inner ends. This plunger, having a cross-head on the middle of its length between the pumps, was connected to the cross-head of a horizon

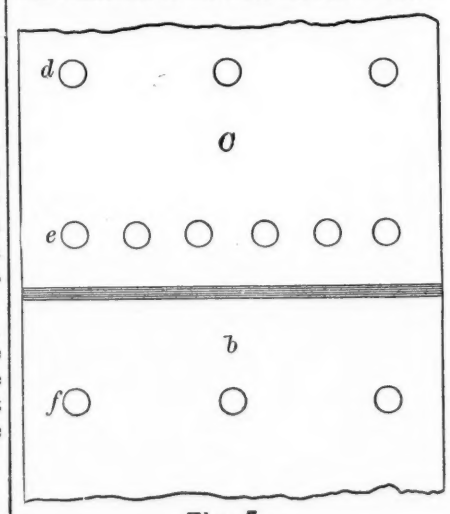


Fig. 5.

tal engine fastened in a line upon the same frame. The air was cooled by being exposed to a body of water inside of the air cylinder and discharge pipe, up to the discharge valve. This was a very crude, wasteful, and straggling machine. It was superseded by a machine having a piston working in a single cylinder, and using a spray or jet of water at each end of the cylinder to cool the air. This was considered by the manufacturers a much more efficient machine, from the fact that it could be run faster, not having a column of water to move at each stroke.

In this country vertical compressors have been built, some with the air cylinders inverted, driven by a shaft from below, and with a vertical engine driving the shaft. And others again, on much the same principle, with a vertical engine driving an overhead shaft, from which trunk pistons were worked in vertical cylinders below. In the first of this class of vertical machines, a jet of water to cool the air was entered on the top of the cylinders, there being two of them. In the second plan, cooling was done by con-

duction on what is generally called the dry system, water being allowed to circulate around the cylinder shell in which the air was compressed. This shell being surrounded by a water jacket, and water being conveyed to the inside of the trunk piston, which was shed by the piston on its top stroke, through holes in the cylinder shell, into the water jacket, the water in this jacket being lower than the holes. By this means a very perfect and simple mode of cooling was obtained without bringing the air into contact with the water. Another plan, which has met with good success, is to allow the water to circulate around the cylinder shell, and also to introduce the water through the piston rod, into the piston, the water cooling the piston and lubricating the piston rings at the same time.

Steam-Engine Economy.

BY F. F. HEMENWAY.

Nine of every ten discussions of steam engine economy begin and leave off with the cylinder, probably, because the indicator affords ready means for examination and comparison no further. Undoubtedly the cylinder is a good place to begin such discussions, because it is the beginning of the engine; but it is a poor place to leave off, because it is a long way from the end of it. If it were possible to separate the cylinder economy so as to make it stand as something distinct—something neither affected by nor affecting any of the other part or parts—this, so far as it goes, might be well enough; but this, however desirable, we cannot do, and that for obvious reasons. There are other economical considerations so connected with, as to be practically inseparable from, cylinder economy. For instance, there is an economy which has to do with the friction of connections, and might be called crank-pin economy. Then there is another, which relates to repairs; and another, which has to do with enforced stoppages; and still another, which is qualified by the lasting properties; and, last, and, generally, least, the economy in first cost. Now, it is possible to increase any one of these at the expense of the others, and the fact that this is done, and, notably, in favor of the cylinder, is the principal reason why the indicator diagram is not a sure exponent of engine economy. The designing and proportioning of the several parts of a steam engine is simply a compromise, and as, in all compromises, something is sacrificed and something gained, so, in this, something is sacrificed at every essential point, and something is, or ought to be, gained as a compensation. An engine would be no credit to the designer—the parts of which were so massive as to preclude all *possibility* of breaking, or the wearing surfaces of which were so ample as to defy all calculations as to when they would wear out—if it could be demonstrated, as it undoubtedly could be, that it cost a good deal of coal to keep the superabundant weight and surfaces in motion. Still less defensible would be a design, the parts of which would be liable to fracture or constant derangement from a lack of material. Is not the engineering equally censurable which aims to produce the most perfect diagram, regardless of other conditions adversely affected by the means employed to bring about this end? This special-construction mania comes around at quite regular intervals, and seldom attacks more than one thing at a time. Sometimes it is unnatural piston speed, and, again, it is excessive pressure, or superheating, or steam jacketing; and the virtual failure of all of them proves—not that there may not be some virtue in any, or all, of them, but, simply, that one idea won't make a good steam engine. It is a simple matter to make some special part of any machine all right if we consider it by itself; but when its relations to the other members of the machine are considered, a different consideration of the subject is usually required. Take two engines of equal capacity and let one cost five hundred dollars more than the other. If the higher-priced one does the same work with 100 lbs. of coal less than the cheaper one, it don't take much arithmetic to prove that five hundred dollars to be paying good interest. If this were all, the matter would be plain enough, but it isn't all. If the higher-priced engine shall cost but twenty cents more a day in the way of repairs, the case is entirely reversed, and the extra amount has been thrown away. The higher cylinder economy has been more than reversed by the lower economy of repairs. In many manufacturing interests two or three enforced stoppages would be even more effective to reverse the seeming economy. In like manner, it may be as readily demonstrated, that with equal cylinder economy the one engine may be so much more economical than the other as to make the price paid of little consequence. While it is desirable for one of the parties to the transaction to buy a good engine for a little money, there are other things of greater importance than the dollars and cents paid. Unfortunately, the price paid for an engine too often begins, and the coal required to keep it moving concludes, all the consideration given the subject, and the engineering practice which has grown from this one-sided view of the subject, of using the smallest practicable cylinder, and driving at an unreasonable number of revolutions for the purpose of showing a small *temporary* gain, is hardly as commendable, because not as safe, as our grandfather's plan of using a cylinder large enough for a refrigerator, and allowing the piston to take its own time. Theory and practice will agree that the engine is the best for the purpose which delivers to the shaft a definite amount of power at the least cost; but while we may, if we choose, begin to count the cost at the coal pile, we can't stop there. A case directly to the point came under my observation not long since. Upon the representation of a builder of considerable prominence, an engine was put in to drive the machinery of a mill. The capacity of the cylinder of this engine was less than one-half that of the cylinder of the engine which had been driving this machinery, and the change was made simply on economical grounds.

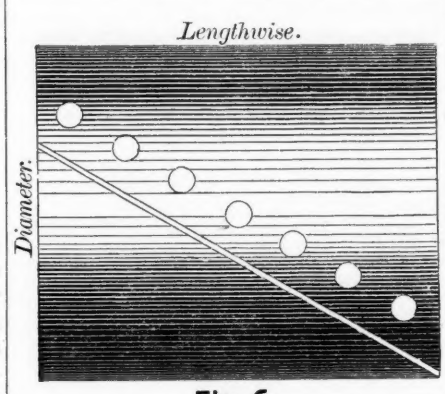


Fig. 6.

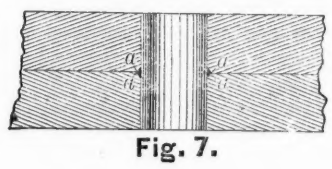


Fig. 7.

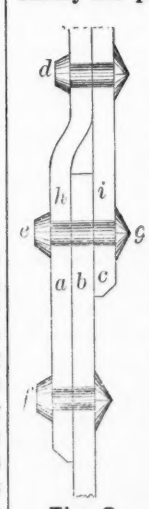


Fig. 8.

The new engine was condensing—the old one being non-condensing—and seemed substantially built, with ample wearing surfaces, etc. The cylinder of the old engine was, undoubtedly, too large for the work, and the piston speed was just as it should have been under the circumstances, quite slow; but it kept turning anywhere from ten to twenty-four hours a day, and six days of the week. Of course, the new engine was run as fast as was thought practicable, and *figured* to do the work all right. Diagrams were freely exhibited from both cylinders, and wonderful economical results predicted. As might have been expected, the new engine showed quite a saving *in coal*, but it lost at two essential points: It cost too much for repairs, which might have been endured but for the more important fact that it brought about too much stopping of the machinery. The result was, the superintendent, who, although not professing any theoretical, or much practical knowledge of the steam engine, thoroughly understood his business and figured the cost of production by the yard, had the demoralized remains of that engine standing quietly under the shed in less than a year, and the belt back on the old one. There is'nt a reasonable doubt but an intelligent jury would have found a verdict of death from too many revolutions. Without taking testimony, however, that superintendent thoroughly understands the necessity of going behind the coal pile to determine steam-engine economy. I have always believed he could strike a balance something as follows:

ENGINE ACCOUNT.	DR.	CR.
Cost of engine and foundation.	$3000	
" repairs and stoppages..	1000	
" removing engine.....	100	
Coal saved in 1 year, 75 tons at $4.....		$300
Present value of engine.... ...		500
Profit and loss.....		3300
	$4100	$4100

If, to put it as one of your contributors does, that engine had stopped at the cross-head, the result might have been different; but it didn't stop there, and the very operations which brought about high cylinder economy, speedily destroyed the balance of the engine. Only a few days since I saw a small automatic engine being removed to make room for a throttling engine, without any especial merit except that it had stroke enough to be run at a moderate number of revolutions. The automatic engine crowded out a throttling engine some four years since, of about the capacity of the one just put in. The only trouble with the automatic engine was in the attempt to supplement its normal capacity, by an unnatural number of revolutions. It was a very nice machine of its class, and started off finely, diagrams from the cylinder being published at the time to illustrate a correct practice. At the present time there isn't enough of it left to repair. If we take for example two engines, the cylinders of each being 12" in diameter, and the stroke of one being 18", while the stroke of the other is 36", we shall have representations of what might be termed, for stationary purposes, short and long stroke engines. At the same piston speed the short cylinder will undoubtedly show the best diagram. What it loses in clearance will be counterbalanced by the greater condensation in the long cylinder. It by no means follows, however, that this proves the short stroke engine to be the most economical in its operation. The crank-pin must make twice as many revolutions in the brasses, and the cross-head brasses twice as many vibrations on the pin, to accomplish the same piston speed in the one case as in the other. This has compelled the practice of making these important parts much larger for a short, than for a long, stroke engine. Now, twice the revolutions and twice the vibrations on larger pins must mean a large increase in friction and wear. For similar reasons the friction and wear of the valves and valve gear must be increased in the same proportion. If we pass to the cylinder and guides, it will be seen that one half the surface must stand the same amount of wear in the one instance as in the other, thereby bringing about a derangement of these parts in one half the time. Again, twice the revolutions means twice the centers to pass, and any amount of *theory* can not put down the *fact*, that the reciprocating engine gets its hardest usage at and near the extremities of its stroke. Is it good practice to increase these points of hard usage, double the friction and wear of brasses, pins, valves and valve gear, and at the same time reduce, by one half, the time the cylinder and slides may be supposed to keep in reasonable condition? It is not a question of piston speed, but it is a question of *revolutions*. If, however, we make it a question of speed, it would be perfectly legitimate to run the 36" stroke at 125 revolutions, but the operative engineer who has the engine to care for would rather be excused from making an every day business of getting 250 revolutions out of the 18" stroke.

Rotative Pumping Engine Duty.

PASSAIC, N. J., Nov. 16th, 1879

Editor American Machinist:

As there has been a good deal said lately relative to rotative compound pumping engines now in operation in this country, perhaps a little back record touching that style of engine abroad would not be out of place.

One of Mr. D. Thompson's double cylinder (compound) engines was *guaranteed* to do 100,000,000 duty with 112 pounds of Welsh coal. (The total heat of combustion of which is for one pound 14.819 thermal units.)

The high pressure cylinder was 28" diameter, with a stroke of 5 feet, 6⅜. The low pressure cylinder was 46" diameter, with a stroke of 8 feet. The initial pressure on high pressure piston was designed to be 35 pounds per square inch.

That the engines were fully up to the contract is quite evident from the following official report. (These engines were afterwards called the Simpson engine).

W. H. HOFFMAN.

REPORT.

To the Chairman and Directors of the Chelsea Water Works Company.

GENTLEMEN:—

I have tested the performance of the two pairs of pumping engines erected for your company at Thames Ditton, by William Simpson & Co.

The trial was continued for twenty-four hours, the coal consumed, and the work done being accurately noted; the fires at the commencement and the close of the experiment being fully charged with coal. The average revolution of engines was 14.44 per minute. The water was delivered from the pumps under a pressure as indicated by a mercurial and a Bourdon's gauge, of 234½ feet, being an average of observations taken every half hour.

The quantity of water delivered into the reservoir was 11,287,208 *English gallons* in 24 hours. The quantity of coal consumed in 24 hours was 255 cwt.

The duty, therefore, of 112 pounds of coal, was 103.$\frac{9}{10}$ millions of pounds raised one foot high.

After the experiment of 24 hours was ended, one pair of engines was stopped, and the other pair worked at such a rate as to raise seven and a half millions of gallons in 24 hours; these were then stopped and the other pair worked up to the same speed. The boilers, engines and pumps performed in a most satisfactory manner.

I am, gentlemen, yours very truly,

JOSHUA FIELD.

LAMBETH, April 9th, 1857.

P. S.—I should have mentioned the famous test of Taylor's *Cornish* Engine, Bucket and Plunge Pump—steam cylinder, 85"x10 feet, 8½ strokes per minute. Steam at 40 pounds initial. The average cut-off for the whole year of 1842 was about one-ninth of the stroke. There were three used during the year; one-seventh, one-ninth and one-eleventh. The engine was at work at the United Mines. The average *daily* duty for *twelve months* was 107,000,000 of pounds raised one foot high with 95 pounds of Welsh coals, and there is no record of any body "flying off the handle" about it, either.

W. H. H.

There has just been turned out of the Philadelphia and Reading car shops, at Reading, according to the *Times and Despatch*, a new passenger locomotive, which will shortly make a trial trip. It will use coal dirt as fuel, and it is expected that it will be the fastest ever built by the Reading Railroad Company, the speed having been estimated at 75 miles per hour. It has four driving wheels, each five feet seven inches in diameter, and four truck wheels, each thirty inches in diameter. The fire box is eight feet long by eight and a quarter feet wide. The cabin is placed over the middle part of the boiler, instead of over the fire box, as in ordinary locomotives.

A large grain elevator at the Eads jetties below New Orleans, La., is in contemplation.

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NEW YORK, DECEMBER 6, 1879.

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Mechanical Intolerance.

The science of mechanics is progressive. Certain facts in it are established beyond any reasonable doubt, but many things are yet subjects of experiment and controversy, not having been clearly proved or disproved so as to make their settlement conclusive. The open discussion of these questions often develops a degree of intolerance among certain leading engineers that works serious disadvantage to the profession. Intolerance is the worst distemper that seizes upon the master spirits of mechanical progress. Often when an engineer holds views at variance with most of his contemporaries he is so positive as to brook no opposition. He hotly decries the merits and ability of all those who combat his position upon the question at issue. He tries to persuade every casual visitor to his office that certain of his contemporaries are donkeys because they do not agree with his views.

Again, we often see an engineer successful in some chosen specialty trying to build up a peculiar theory or system of his own, and endeavoring to overthrow everything that will not conform to it. Sometimes his zeal leads him to write a book, assailing the published works of other engineers which have been proved of great practical value, a course which usually gives him notoriety, if not popularity, and affords a relief to his combativeness.

Students of engineering find so many contradictory assertions put forth, by those who are believed to be competent authorities upon mechanical matters, that they become confused and led astray in the pursuit of correct knowledge. In most cases these erratic assertions are circulated to gratify a spirit of intolerance directed against some fortunate competitor. Experts frequently delight in laying pitfalls for each other. Instead of uniting to advance mechanical discovery, they too often diverge to hinder it. Such exhibitions of intolerance re-act upon their authors, by creating public distrust in every mechanical decision made by the parties. If one engineer goes somewhat in advance of generally accepted mechanical knowledge, and makes an important discovery, he is obliged, in many cases, to defeat the jealous obstinacy of a whole category of self-styled experts, before he can open a clear road for its application. When an engineer gets in the way of decrying all original results obtained by any of his contemporaries it is best to give him a free field and let him "go it alone" unaided. This course will soon bring him to a better and more liberal understanding of the principles of mutual dependence. Intolerance always represses, never helps, the evolvement of mechanical truths. In the light of modern progress such a distemper should receive no encouragement.

The Prison Labor Muddle Again.

What the three states of Massachusetts, Connecticut and New Jersey have gained by the recent session of their joint committee on the Prison Labor Contract System may be conjectured, but the presumption is not flattering, owing largely to the character of the testimony taken. In such investigations, it seems inevitable that the witness stand must become a sort of refuge for a swarm of dilettante special pleaders, arguing in favor of the system in question, rather than testifying to the facts, upon the one hand, and a delegation of aggrieved manufacturers damaging their own cause by the advocacy of impracticable remedies (such as abolishing the use of machinery in prisons) upon the other. Out of such testimony not much real information seems likely to be extracted regarding a question so difficult and complicated, as the question under review. Then again, public sentiment is befogged by long newspaper disquisitions upon the admitted importance, not only of making our prisons reformatory in their discipline, but of giving convicts a course of training which will be useful to them in after life. No sensible opponent of the prison labor contract system, as now practised, denies the value of either of these propositions.

On the contrary, the contract system is open to attack for the very reason that it brutalizes the convicts, by making them slaves to mercenary taskmasters who care nothing for their reform or well-being, without giving them any sufficient knowledge of any business to make them practical self-supporting mechanics.

For months past the AMERICAN MACHINIST has been making what some of its friends have deemed a hopeless war upon this iniquitous system. We are pleased, however, to note so powerful an ally as the *New York Herald*, which well says in its issue of Nov. 15, with reference to one of these very points, viz: the reformatory aspect of the contract system:

What are the reformatory influences provided by a State for the benefit of its criminals? Punishment always, generally a chaplain, and sometimes a library—only these, and nothing more. What are the influences beside the perverted nature of the prisoners, that oppose these? A great many, but in many States the worst is the contract labor system, by which the men are placed practically, body and soul, under the control of contractors who consider themselves charged only with the duty of getting the greatest possible quantity of labor for the smallest possible pay. A contractor determines how much per day a man should do of a certain kind of work, and the rule is uniform, regardless of the condition of the prisoner, provided he is not excused on account of sickness. If the work is not done the prisoner must be punished—not for his own good, not for an actual offence, not for the benefit of the State or community, but solely that the contractor shall not suffer a few cents in pocket. If a more brutalizing system has ever existed in penal institutions history has kept silence about it. For nearly a quarter of a century the civilized world has sorrowed over the prison sufferings of Jean Valjean, who went into jail a tender-hearted youth and emerged a hardened criminal, but many a New York convict suffers more severely and unnecessarily than the hero of "Les Miserables."

What is the economic result of this submission of the State to contractors, and the consequent intensifying of every bad habit of the convict, is not hard to imagine. The loss to which a professional criminal subjects the State cannot be made good by the labor of half a dozen honest men, for the expenses of trials, incarcerations, &c., are but a small part of the total. Many of them leave families of paupers behind them, while every one of them who lives by his profession wastes many times as much as he uses. A pickpocket steals a watch worth two hundred dollars and sells it for twenty; a burglar gets for his share of a house robbery about one-tenth as much as will have to be expended in replacing the stolen articles. The community loses at this rate by many a rascal, who might have been reformed in prison had not an itch for the semblance of economy turned the man over to a set of taskmasters, whose system would ruin any honest mechanic and can do nothing for a bad man but make him worse.

Now, with regard to the practical training that a convict gains while his labor is being farmed out to self-seeking contractors at 40 cents a day, it should be considered, that the convict is kept slaving away, week in and week out, month in and month out, perhaps year in and year out, upon some one single detail of manual work, and leaves the prison at the close of his term with just enough knowledge of the branch of manufacture at which he has been employed to make him helpless and desperate, when the necessity of earning a living by it is forced upon him. What this question wants is the consideration of law-makers far seeing enough to discern, that a state or city cannot afford to make its prisons ostensibly self-supporting, at so great cost to the thousands of honest artisans whose livelihood is destroyed by such unequal competition; that a moderate, direct tax, if necessary, to be paid by the whole community to supply an honest deficit, incurred in its prison management, is more economical and just than the pretended savings now gained at the expense of convict and community alike; and that reasonably managed prisons, which diversify the industries practised in them, as well as train the convict into a complete knowledge of the special trade selected by him, are necessities—to gain which no amount of patient statesmanship will be thrown away.

As to the argument, that a system, whose ends are so clearly defined, cannot be changed without leaving the community helpless in the hands of political thieves, so far as its prison management is concerned, no man, who has any faith left in human nature, will consider it unanswerable. Whatever change is made must be made by law, and knowing the danger the lawmaker needs but a small modicum of common sense to enable him to avoid it. Proper methods of appointment and undivided responsibility of prison officials should secure at least decent management, and even a pretty stiff dose of indecent management would be more tolerable all round than a return to the present brutalizing, unjust and unthrifty methods.

Prospects of Adverse Legislation.

The present session of Congress opens with the country in a much different position, as to the prosperity of all legitimate industries, than at the close of the last session. Manufactures and trade have experienced such a revival as to place languishing business enterprises upon a better and more substantial basis. The future looks more hopeful than upon any other assembling of Congress since the panic of 1873. Its continued brightness would seem to depend largely, to use a hackneyed phrase, upon preserving the *statu quo*. It is not probable that any startling financial legislation will be indulged in this winter, but there is a cause of apprehension to which public notice has been but little directed. The advancing prices, and increasing demand for iron and steel, have not only stimulated production throughout the country, but have given rise to considerable importations. So long as prices are maintained these importations are likely to continue. Low prices of iron in Europe, taken in connection with heavy producing capacities, must always have an important bearing upon our markets. The only thing preventing permanent depression of our iron and steel manufactures is a strong protective tariff. There is no other safeguard against crowding our markets with a foreign product to the serious damage of American manufacturers and workmen. Does any intelligent and well-informed citizen believe that, without a protective tariff, we could have reached our present grade of prosperity?

A concerted effort is now being made to reduce the tariff in the interest of a few importers and certain establishments they have connections with on each side of the Atlantic. If it is done the business boom must receive a check. Prices of iron and steel goods must then decline, wages decline, and more or less workmen be thrown out of employment. This is no imaginary picture. Just such a movement has been tried before, and has every time resulted in disaster. The question will again come before Congress this winter, and the people will watch with great interest for its rightful disposition.

Engravings and Electrotypes.

In last week's issue Mr. Park Benjamin threw out some pointed suggestions about preparing trade catalogues and circulars. Our experience prompts us to offer a few remarks about engravings and electrotypes. If a machinery manufacturer has a magnified notion of "economy," he will be almost sure to send his drawings or photographs to from two to six wood engravers, soliciting estimates on cost of making cuts, and will accept the cheapest offer. A "first-class job" is invariably promised. When the blocks are received, with prints of the same, the economical machinery maker is apt to discover that the "effect" of the views is very different from a contemplation of the original objects. Then follow alterations, loss of patience, and a final resolution to "let it go." If the first decision was a mistake, the last can be called nothing better than a blunder.

The purpose of an engraving is to give a correct representation of a machine to enable those who do not see it to obtain an idea of its appearance. Now, what kind of economy is it to send a prospective purchaser a distorted and unattractive view of the machine he is likely to want? Better use the cut for kindling wood and have another

made by an engraver who knows a machine handle from a monkey-wrench, and who can, and habitually does, "sculp" accurate representations of mechanical objects. A poor engraving is dear at any price; a good one is cheap at twice or thrice the amount asked for the former. Our most successful machinery manufacturers will fully substantiate this declaration.

We receive many catalogues and circulars from manufacturers exhibiting views of machines and tools that might consistently be used to embellish the pages of a comic almanac. Some are wood engravings, and others apparently made by a cheap "process." A good machine is often condemned by reason of a poor representation on paper. Good engravings aid largely in selling machinery at full prices. To many people, a cheap, poorly executed engraving conveys the idea that the manufacturer secures no greater excellence in the machine itself than in its representation.

The wood cut should only be used as a pattern from which to make electrotypes for printing. These cost but little. The aforesaid economical machinery maker has *one electrotype* made from each engraving, and lays away the latter so carefully that he can hunt it up only at the semi-annual stock-taking, about Christmas, or the fourth of July. The former he sends to some printer or publisher, and has about an even chance of getting it again within six months. (We claim a little indulgence here, never having lost an electrotype since the AMERICAN MACHINIST came into existence.) It has often been our fortune to see parties lose $10 worth of time and effort in writing and searching for a 25 cent electrotype.

Sometimes careless individuals will have no electrotypes made, but use the wood cut itself for printing. It is, in such cases, likely to be spoiled. When the original cut is lost or spoiled, an electrotype may be used as a pattern and duplicated just the same as the cut itself. It would pay manufacturers to give this subject more attention.

The reason that no Extracts from Chordal's Letters appear in this issue is that we have seventeen engravings to accompany the next Extracts, which are not yet ready. The subject treated is of unusual interest to engineers, and we hope to present it in a week or two.

Boiler makers and steam users would all do well to read carefully Mr. W. H. Hoffman's series of articles on Boiler Proportion and Construction, now appearing in our columns and which will be continued for several weeks to come. Mr. Hoffman has no interest in any patent boiler, and writes from the standpoint of a thoroughly qualified and disinterested mechanical engineer.

Friendly Comments.

(*From the Poughkeepsie Daily Eagle.*)

A GOOD PAPER.—The AMERICAN MACHINIST, published at 96 Fulton st., New York, has just entered upon its third year of publication. It is as its name indicates a paper for the Machinist and practical Engineer, and is filled every week with articles of especial value to these classes. A copy of it should be in every machine shop, if not in the hands of every employee there. The result could not fail to benefit the trade in making better mechanics and better work.

(*From the Watertown (N. Y.) Daily Times.*)

THE AMERICAN MACHINIST, devoted to the interests of machinists, engineers, founders, boiler makers, pattern makers and blacksmiths, commences upon its third year with this week's number. It is now a sixteen page weekly, illustrated in an elegant manner, and printed handsomely on fine paper. We know of no way that a mechanic, who wishes to keep up with the times, can invest $3.00 so well as to subscribe for this journal.

(*From The Times, Marlborough, Mass.*)

The AMERICAN MACHINIST, an illustrated weekly paper, devoted to the interests of machinists, engineers, manufacturers and inventors, and everybody else who takes an interest in practical mechanics—or theoretical either, for that matter—is before us as we write, and a cursory glance at its profusely illustrated and clearly printed pages leads us to the belief that it is just what every manipulator of minerals and metals ought to have. It seems to have all the desirable features of the——— ———, with none of the undeniably objectionable peculiarities which mar the latter.

(*From the Norristown Herald.*)

THE AMERICAN MACHINIST, New York, has entered upon its third year, with a large and increasing patronage. It is a very handsome and valuable weekly, employing able writers in all its departments. The subscription price is $3 a year.

(*From the Wilmington Morning Herald.*)

The AMERICAN MACHINIST of New York has just entered on its third year as bright as ever.

(*From the Steubenville Daily Herald.*)

The AMERICAN MACHINIST, published at New York, enters upon its third year this week. It is a deserving publication and should be in the hands of every engineer, draughtsman, machinist and architect.

(*From the Columbia (Pa.) Courant.*)

AMERICAN MACHINIST.—This is one of the best magazines for mechanics, engineers, inventors, etc., that we know of. With the number bearing date November 15, begins the third year of successful publication. Issued weekly at $3 per annum. Single copies six cents. Address 96 Fulton street, New York.

(*From the Philadelphia Trade Journal.*)

The AMERICAN MACHINIST, with its last issue entered the third year of its publication. At first a monthly, it has been published weekly since June last. The AMERICAN MACHINIST is and has always been one of the best special trade papers that we know of, and is always full of valuable information. It should be found on the desk of every manufacturer, machinist and engineer. Our contemporary has our best wishes for future success.

(*From the Jersey City Evening Journal.*)

Among the numerous technical journals of high excellence that now abound, one of the latest established is the AMERICAN MACHINIST, which has in an unprecedentedly short time, forced its way into the very front rank of this class of publications, both as to circulation and influence. Although only beginning the third year of its existence it has already obtained a weekly circulation of nearly 9,000 copies, a success almost unparalleled. It has, however, been fairly deserved, for the discussions and articles that have filled the columns of the MACHINIST have been in all cases of wide scope, great practical value, thoroughly alive and timely, and the production of specialists of acknowledged eminence, such as Thurston, Emery, Nystrom, Hill, Lyne, Porter, Grant, Buell and others. It is an invaluable source of information for all engaged in the different departments of mechanical, civil and steam engineering, and should be in the hands of every mechanic and engineer in every workshop in the country. Its influence in raising the standard of mechanical labor and promoting thought and a desire for improvement among artisans and mechanics is invaluable.

Business Specials.

Forty cents a line for each insertion under this head.

Brown & Sharpe M'f'g Co., Providence, R. I., keep in stock at reduced prices Patent Cutters for the teeth of gears which can be sharpened by grinding without changing their form. All wheels of same pitch cut with them will run together correctly. Send for new catalogue.

The Huntoon Steam Governor Co., of Lawrence, Mass., warrant a direct saving in steam of from 10 to 20 per cent. over any other Governor known; while for quick and accurate regulation, great durability and lasting economy in use, they guarantee results never before attained by any other. See advertisement.

Calvin Carr, Cleveland, O., and 44 Centre Street, New York, Galvanized Iron Cornice Machinery.

Lathe Attachments for Milling Plane and Irregular Forms; Taps and Reamers fluted and Gears cut without removing from the lathe centers. For extended description, see AMERICAN MACHINIST, Sept. 13 and 20 issues. Send for circular to Wm. Main, Piermont, N. Y.

Tool Chests with best tools, scroll saws, wood and designs. Amateurs' and Machinists' Tools. Send for Catalogue. Tallman & McFadden, Philadelphia.

12 Plain Milling Machines, improved pattern, weight 1,400 lbs. each, just finished and ready for immediate delivery. Brainard Milling Machine Co., Hyde Park, Mass.

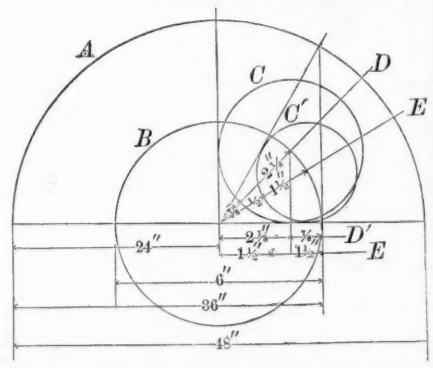
How to lay out the teeth of Gear Wheels. Price 50 cents. Address E. Lyman, C. E., New Haven, Ct.

For sale low, 6 and 20-horse Portable Engines. 7 x 14, 7 x 20, and 16 x 48 inch. Horizontal Engines. 3 x 13½, 3½ x 14, and 4 x 14 foot Tubular Boilers. All guaranteed to be in a No. 1 condition. Other sizes on hand. Belcher & Bagnall, 40 Cortlandt St., New York.

Questions and Answers.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly and according to common sense methods.

(1) J. M., Cleveland, O., writes: Will you please give me some rule for finding the lap on a slide valve. Suppose the engine is 48in. stroke, travel of valve 6in., what lap is required to cut off at one half stroke? *A.* Rule. Length of stroke of piston and throw of valve being known. From the length of the stroke of the piston, subtract the length of that part of the stroke that is to be made, before steam is cut off. Divide the remainder by the length of the stroke of the piston, and subtract the square root of the quotient. Multiply the square root thus found by one half the length of the stroke of the valve, and from the product take one half the lead (if any) and the remainder will be the amount of lap required. For cutting off at ½ stroke. Thus, $24'' - 48'' = 24 \div 48 = \sqrt{.5} = .707 \times 3 = 2.121''$ lap. Or to cut off at ¾ of the stroke. Thus $36'' - 48'' = 12 \div 48 = .25 = \sqrt{.05} \times 3 = 1.5''$ lap required. Or see Haswell's Engineers and Machinists Pocket Book: on page 587, factors are given which, multiplied by the length of stroke of valve, will give the required lap. By the aid of the accompanying illustration you



will easily understand the rule. The crank circle is represented by A, the valve travel circle by B, the lap circle for cutting off at ⅝ stroke, by C, and for cutting off at ¾ stroke by C'. The distances are all marked in plain figures, and are correct, with the exception of the distance marked ½in. on the line E, which should be 1½in. as on the line E'. It is not necessary to work out the square root by the formula, as the roots of different numbers can be found in the ordinary tables found in most of the mechanical pocket books. The distances marked on the lines D and D' represent the proportions for cutting off at ⅝ stroke, and the distances on the lines E and E' for cutting off at ¾ stroke.

(2) A. P. B., New York City, asks: 1. Will you please inform a reader which of the two enclosed sketches is the best stack of pipes for heating a room by steam, each having the same number of feet of pipe? Fig. 1 takes steam in all at once, while Fig. 2 has to traverse back and forth. In an argument, the advocate of Fig. 1 says that his is the best, while the advocate of Fig. 2 says that the other (Fig. 1) is a humbug. Letters *a* and *b* represent the valves. *A.* We would say that the principle of Fig. 1 is the best, because the circulation is rapid, unobstructed and will radiate a great deal more heat, while the circulation of Fig. 2 is entirely too slow, and a great deal of the heat is lost. Some of the best heaters are now made with a trap to each section, or, in other words, each section communicates with the steam pipe so that no water accumulates in any of the sections. A little investigation will convince the most skeptical. 2. Can I return the drips to my boiler without a trap, (I carry 60 lbs. of steam). If so, how? *A.* You can, by placing your boiler below the level of all the pipes, return the drips, but we would advise you not to do it, as the water is liable to back up in the pipes as the pressure falls in the boiler, and on a cold night is liable to freeze up and burst the pipes. The advantages gained by the use of the trap are numerous, and will overbalance any extra expense.

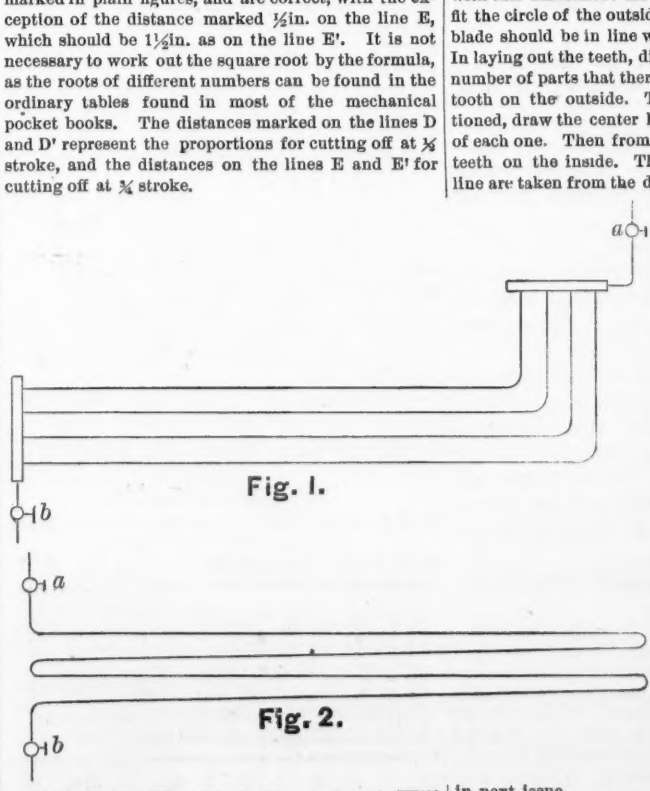
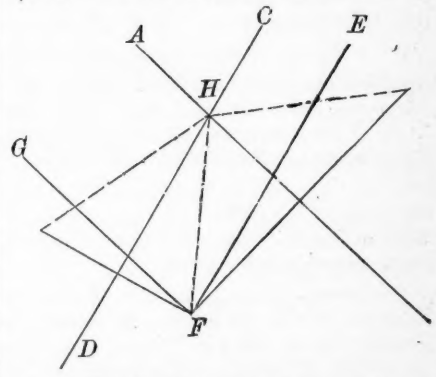


Fig. 1.

Fig. 2.

(3) L. O. C., Sedalia, Mo., writes: I am a young mechanic, and in view of the fact that the older mechanics are very much afraid of telling us young mechanics too much, I consider your Journal the proper source from which to obtain the necessary information as to the following questions, viz.: 1. A cast bevel gear wheel, 27⅜ in. outside face of teeth, 4¼ in. long, depth of tooth 1⅛ in. Is this proportion correct? *A.* There have been a great many gears constructed for which the above proportions would answer, but gears are generally constructed proportionally to the work which they have to do; and in regard to the depth of tooth, we would say that a much shorter tooth is used now, than ever before, and has been found to give satisfaction. 2. The gear mentioned is to run or match into a wood cog wheel; to chip and file the cast gear correctly. How should one proceed to lay it out after it has been turned up in a lathe? *A.* By the aid of the accompanying illustration we will give some plain directions how to get the lines to lay out your gears. To find the proper level for any line or angle: Let A represent the end of a line of shafting, and draw the line C D to represent the line of shafting (which may be drawn at any angle), to which power is to be transmitted. The line C D will also represent the center line of the bevel gear which is to receive the motion. Suppose the shaft C D to revolve three times while the shaft A revolves once, draw the parallel line F E at any moderate distance (for example a foot scale), then draw the parallel line F G at 3 feet distance, after which draw the dotted line F H through the intersection of the shafts A and C D, and likewise through the intersection of the parallel line F E and F G, to the point H, then F H will be the pitch line of two bevel wheels. In laying out the teeth in a bevel gear, a gauge should be made resembling a T square, but with this difference: the stock should be hollowed to fit the circle of the outside of gear. The edge of the blade should be in line with the center of the circle. In laying out the teeth, divide the circle into the same number of parts that there are teeth, and lay out each tooth on the outside. Then, with the gauge mentioned, draw the center line of each tooth on the top of each one. Then from each center line lay off the teeth on the inside. The shape of teeth and pitch line are taken from the drawings, the pitch line being



put on the gear when turned up. 3. The pitch circle on largest diameter was set 3-32 inches outside from center of tooth, and smallest diameter was set 1-16 inch outside of center of tooth, which made the circle ⅛ inch in diameter larger than centre of tooth. Was this correct? *A.* Yes, for some gears, but not for all. 4. Please give a plain correct rule for laying out a gear for chipping and filing, or any other stated size gear. *A.* For chipping and filing, lay out as previously directed, and make your lines fine. It is a good plan to make a tin template for the shape of the tooth, as you will get better results. For instruction on gearing generally, see the articles now being published in the AMERICAN MACHINIST. Your other questions will be answered in next issue.

(4) J. H. H., Syracuse, N. Y., asks for a rule for finding the circumference of different circles without going into decimals. *A.* No accurate rule of this kind can be given. The circumference of a circle can be found very nearly—near enough for any ordinary practice, by multiplying the diameter by

3.1416=$3\frac{177}{1250}$. We advise you to take an arithmetic and study decimal fractions, which are simple and easy to understand. It will probably save you much time and annoyance to become acquainted with decimals.

MANUFACTURES

We learn from W. W. Wilcox, Superintendent, that C. J. L. Meyer, manufacturer of sash, blinds and doors, at Fond du Lac, Wis., has built a machine shop 65x108, and intends building about 20 large stationary engines, varying from 7x12 (15 horse) to 20x30 (100 horse). The shop is furnished with all Putnam tools, lathes with 7 feet 4 inch swing, planers 20x4 feet bed, 20 feet shafting lathes, etc. They make their own patterns and castings, having a pattern shop 36x40 and foundry 60x60. Their cupola has a capacity of melting thirty tons in two hours. They also have brass furnaces for all kinds of brass castings, and run about 25 hands.

W. F. & J. Barnes, at Rockford, Ill., manufacture lathes and foot powers, and are getting out a new catalogue. They run 35 to 40 men 10 hours all the year round. Their works consist of foundry, wood shop, machine shop and paint shop. The works are run by water power entirely. The Rock River at this point has a fall of about 6 feet, giving about 2200 horse power.

The Singer Sewing Machine Works of Elizabeth, N. J., are erecting an additional foundry, 200 by 100 feet. There is said to be no truth in the report that the concern intends to transfer their establishment from Elizabeth. They now employ 1,800 operatives, and turn out 6,000 machines weekly.

Sawtelle & Judd, Hartford, Conn., are building one of their condensers for a firm in Cincinnati. They are running full time on general machine work with plenty of orders for some time to come.

The Whittier Machine Co., Boston, are running full time, with a large force of men. They are building a great many steel boilers for parties who wish security and durability in using steam machinery.

The Pratt & Whitney Co., Hartford, Conn., have been obliged to make an addition to their foundry. They have increased their force 100 men since Jan. 1, last. They report business better than for the last three years, and a hundred per cent. better than one year ago.

The Providence and Worcester Railroad Company are laying the foundations for their new machine and repair shops at Valley Falls, R. I.

The Erie City Iron Works, Erie, Pa., are putting up new boiler shops 350 x 100; cost, $10,000.

The Goulds Manufacturing Co., of Seneca Falls, N. Y., are very busy manufacturing a full line of most excellent pumps. All their pumps are reliable and trustworthy—made from the very best material and by skilled workmen. In sending out their products the company always hold in view the necessity of sustaining their well-earned reputatation, and never slight the smallest details. The company was established in 1848, and now employs 200 men. Their machinery and tools are all of the latest and most approved patterns, and they take the pains to keep them up in good condition. Their pumps are shipped all over the world, and are as well known abroad as at home.—*Railway Review*

Machinists' and Engineers' Supplies.

NEW YORK, Nov. 20, 1879.

Items this week are as scarce as hen's teeth and about as substantial. While business is good, as compared with times before the "boom," there is a lull as compared with the past few months. No novelties are being offered and no changes in prices have occurred that we can hear of, and we have searched diligently with spectacles and a dark lantern.

Emery goods are low and may advance with the new year.

Cotton Waste has advanced one cent per lb. within the last four weeks, and finds a brisk market in England, where they make it up into shoddy cloth for younger sons and decayed gentlemen's wear.

Wrought Iron Pipe may waver somewhat in price, but valves and steam fittings are firm, makers being full of orders till March next.

We can see no indications of any material reaction either in business or prices, other than the natural slackening incident to the season of Thanksgiving turkeys, Christmas gifts and New Year calls.

Iron Review.

NEW YORK, Nov. 20, 1879.

There is nothing new to report, prices continuing firm, without likelihood of weakening. The demand in the Western States is reported exceptionally brisk, and mills full of business. A letter from England reads: "The South Staffordshire makers, such as Bagnalls, Barrows, Brown & Freers, &c., have advanced their list prices 10 shillings per ton, which stiffens prices generally in England, and the tendency continues decidedly upward."

Those persons who have been looking for a break in the prices of iron seem likely, from all that we can learn, to be still further disappointed.

Pierson & Co., 24 Broadway, New York, continue to report prices out of store:

Boiler makers' supplies: Tank Iron, 4½c.; C. No. 1 Boiler Plate, 4¾c; C. H. No. 1 ditto, 5c.; Best Flange ditto, 6c.; Boiler Rivets, 5 to 6c.

Other Iron Supplies: No. IX Pig, $30 to $31 per ton; Iron Rails, $46 to $55, according to weight; Old Rails, $31.50 to $32; Fish Plates, 3c. per lb.; Railway Spikes, 3½c.; Bolts and Nuts, 4½c.; Common Bar Iron, 3c., basis from store; Refined, 3 2-10c., basis; Ulster, 3 8-10c., basis; Machinery Steel, 7c.; Best Tool Steel, 12½c.; Norway Bar Iron, 5¾c.; Norway Shapes, 6c.; Nail Rods, 6 to 6½c.; Sheet Iron, 4½c., basis; Angle Iron, 4c.; Tee Iron, 4½c; Band Iron, 3 6-10c.; Hoop Iron, 3 8-10c.; Horse Shoe Iron, 3 8-10c.; Hot Polished Shafting in lengths, 2 ft. and longer, 7 to 8c., according to size; Small Black Rivets, 50% off in papers, 35% off in bulk.

Metal Review.

LUCIUS HART & CO., 8 & 10 Burling slip, New York, furnish us the following, under date of Nov. 20th, 1879:

The metal market, without much change during last week, is carefully watched by leading dealers, and in Pig Tin especially a sharp turn may occur at any time. London is steady, and strong at £92.10 per ton; Singapore, $27.50 per picul. Would quote to-day, Banca Tin, 25c.; Malacca and Straits, 22c.; Billiton and Australian, nominal, 22c.; "Lamb and Flag," 20½c.; Antimony, owing to scarcity of ores and light stocks of Regulus, is higher, and offerings nil: Cookson, 18c.; other brands, 16½c. Pig lead can be advanced in price if leading holders so decide, price to-day, 5½c. for prime American brands. Spelter is neglected, Domestic, 6c. to 6¼c.; Imported "S. S.," 6¼c. to 6⅜c. Ingot Copper, strong, 21¾c. to 22c.; spot, 22½c., January and February deliveries. Nickel, $1.25 to $1.50. Bismuth, $2.50; Solder, No. 1, 12c.; "Half-and-half," 14c.

Situations Wanted—Help Wanted.

We will publish notices suitable for the above headings, applying to any of the machinery trades, and not to exceed four lines each (32 words), at the nominal rate of twenty-five cents for each insertion.

Position wanted as draughtsman by a practical mechanic; experienced in designing, perfecting, and superintending construction of special machinery. Address, D. C. A., office of AMERICAN MACHINIST, 96 Fulton street, New York.

Situation wanted as a Foreman Boilermaker by a Scotchman with best of recommendations. Has been foreman over six years. Address, BOILERMAKER, office of AMERICAN MACHINIST, 96 Fulton street, New York.

An Eastern man, 38 years of age, with 20 years experience in the construction and manufacture of light machinery and metallic articles, under the American system of duplication; competent to superintend, solicit, estimate cost, correspond, or discharge any of the duties connected with such business, will soon be at liberty, and would be glad to communicate with parties in the West with a view to an engagement. References given. Address P. O. Box 1937, Bridgeport, Conn.

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MOORE'S "UNIVERSAL ASSISTANT AND COMPLETE MECHANIC," enlarged edition, contains 1016 pages, 500 Engravings, 461 Tables, over 1,000,000 Industrial Facts, Calculations, Processes, Rules, Trade Secrets, &c., in every Occupation. A $5 book free by mail for $2.50, worth its weight in gold to any Mechanic, Farmer, or Business man. *Agents Wanted.* One Agent reports only one refusal in obtaining 35 orders. An ad. is utterly inadequate to describe the work. For Ill. Pamphlet send stamp to R. Moore, P.O. 20 Cooper Inst., New York.

W. C. Verder, 404 College Ave., Davenport, Iowa, and Walter Hawley, Sharon Station, Dutchess Co., N. Y., will each pay *one dollar* for a clean copy of Vol. I, No. 1, AMERICAN MACHINIST (November), 1877.

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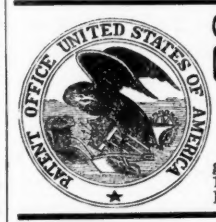

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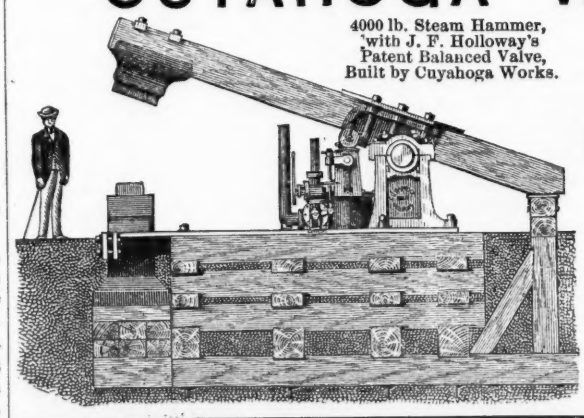
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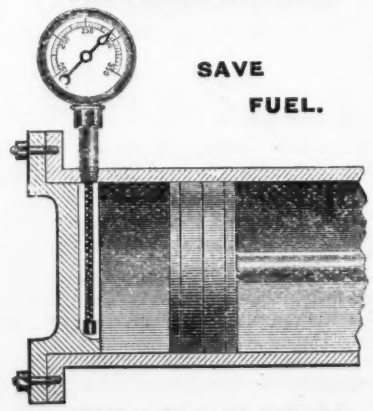

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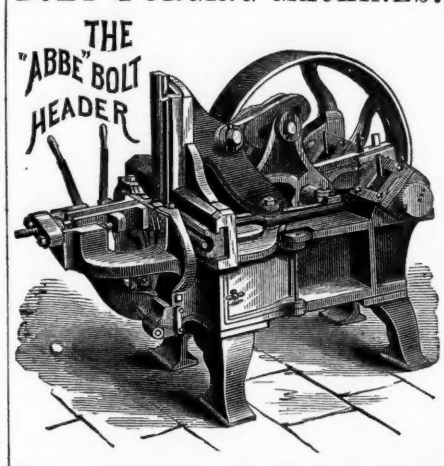

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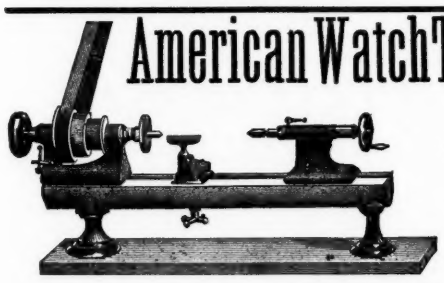

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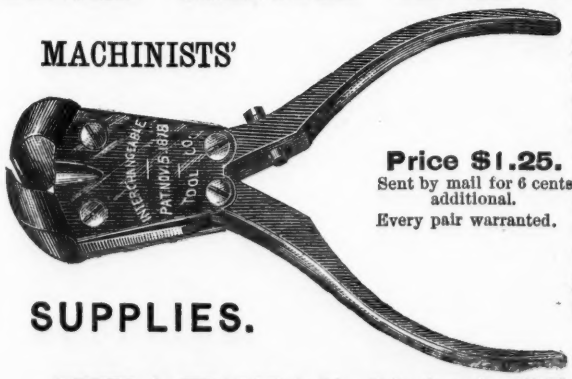

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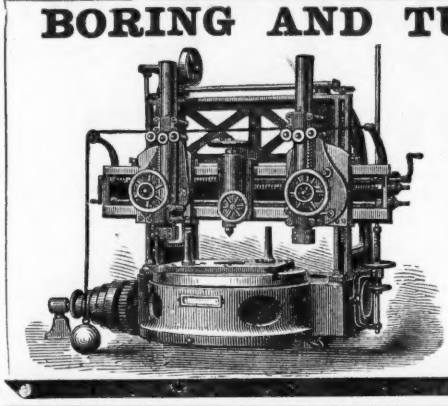

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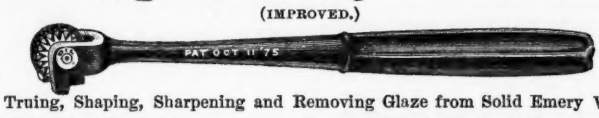

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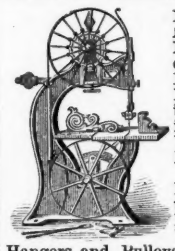

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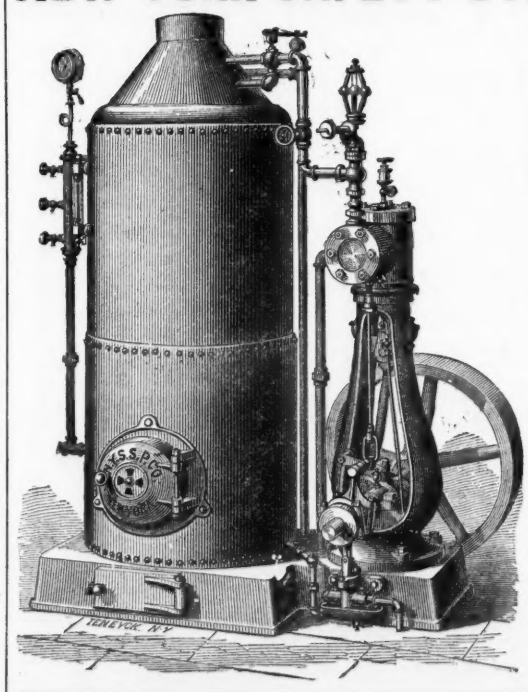

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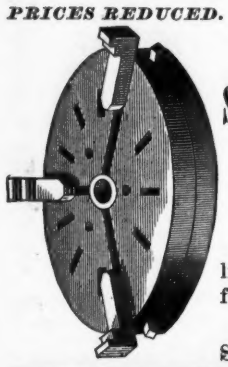

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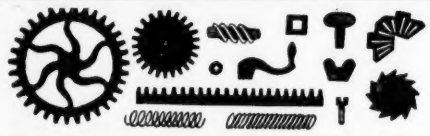

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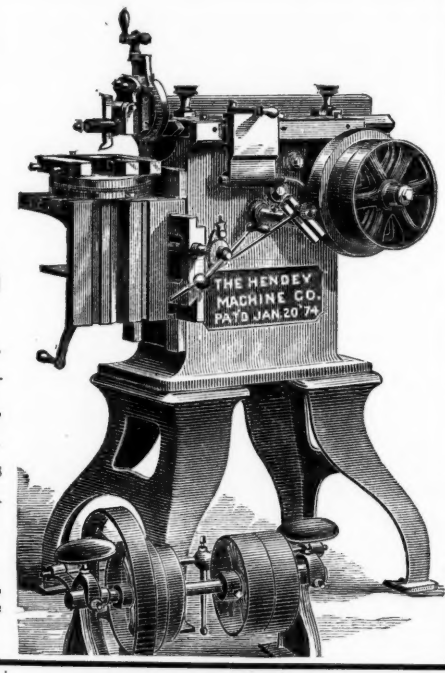

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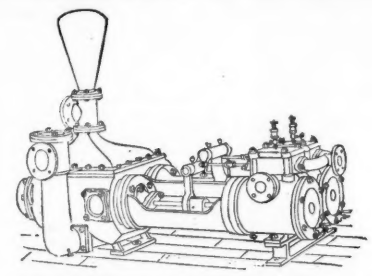

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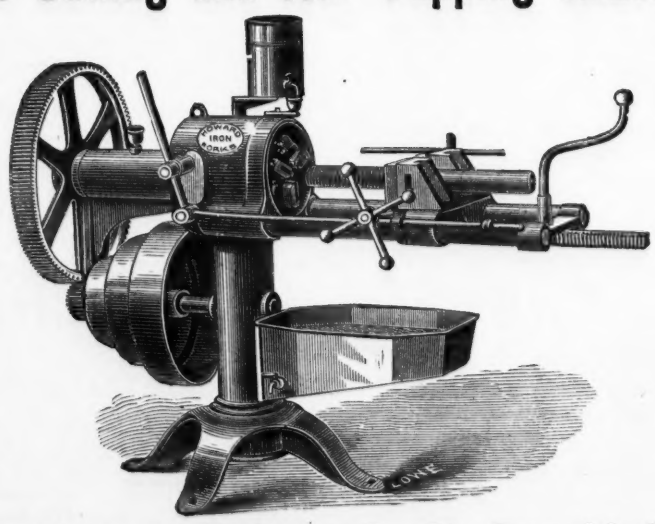

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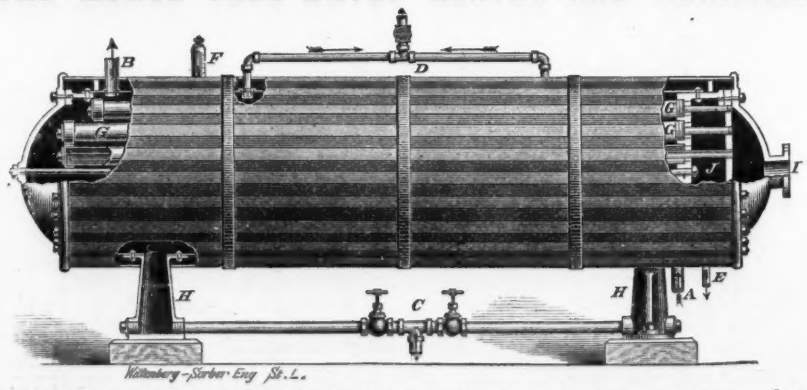

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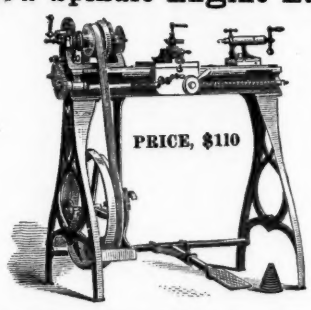

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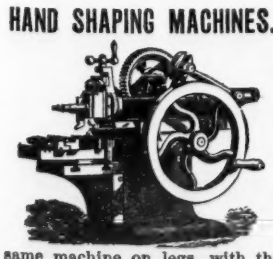

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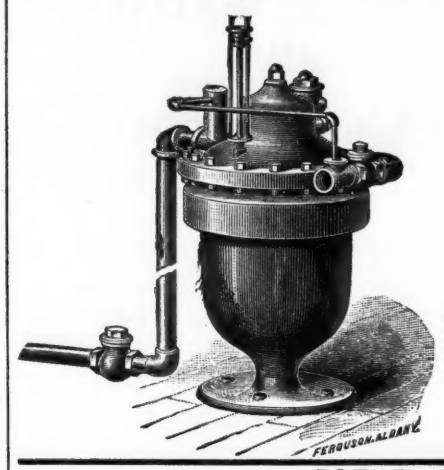

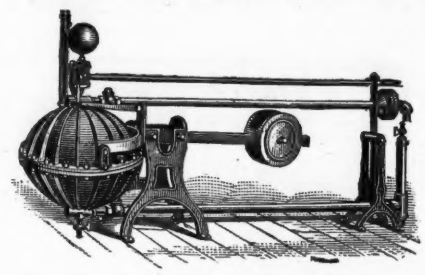

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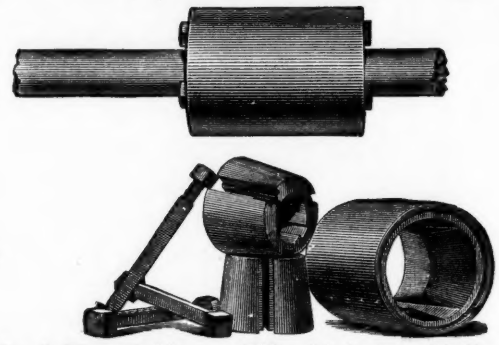

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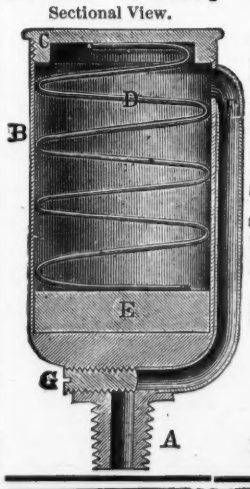

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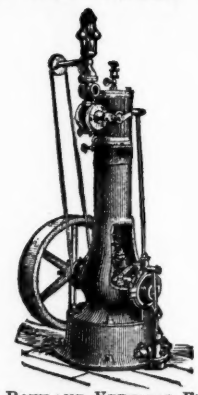

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Prof. John E. Sweet.
Defects in Building Engine Lathes. June 28, 1879.
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Engine Construction. August 9, 1879.
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Marine Governors. October 18, 1879.

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Strength of Steam Boilers. July, 1878.
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Use of Lubricants. September 20, Nov. 1, 1879.

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Talks. Nov. 22, 1879.

Charles A. Hague.
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Piston Speed and Steam Compression. October 4, 1879.

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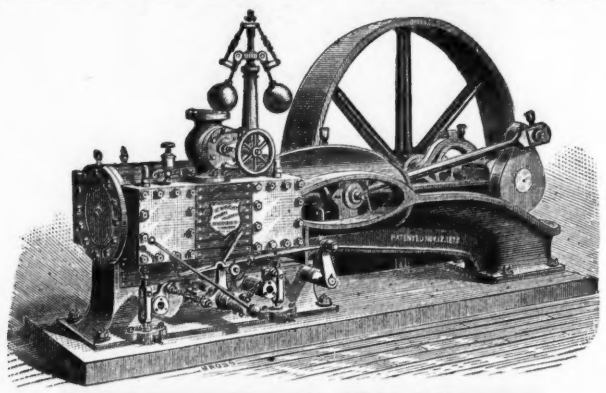

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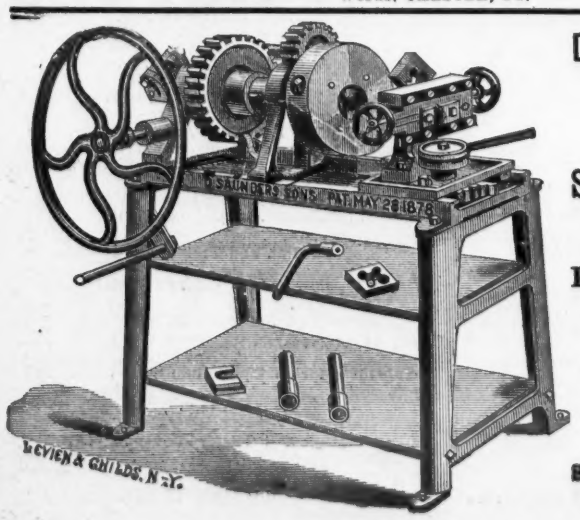

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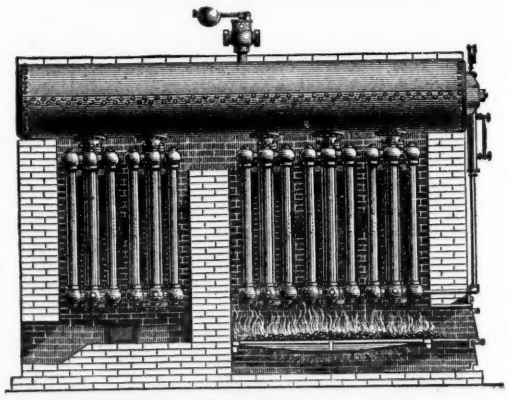

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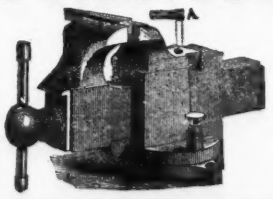

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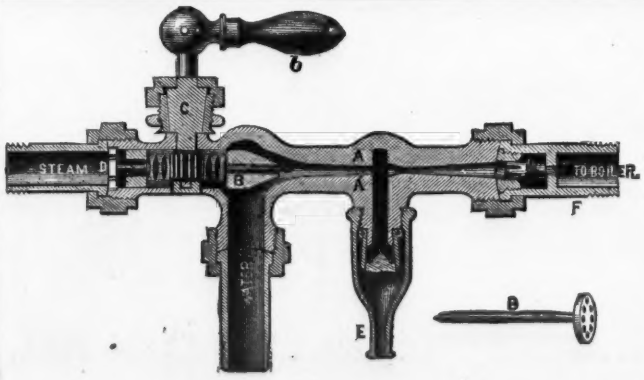

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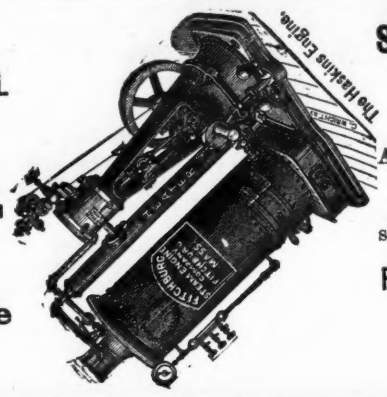

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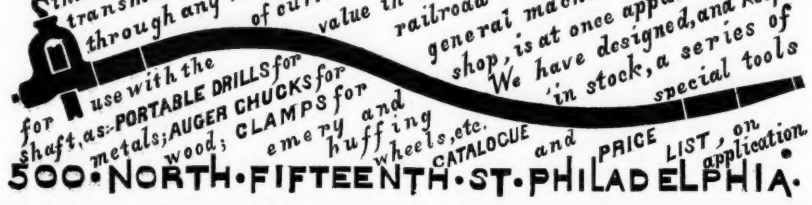
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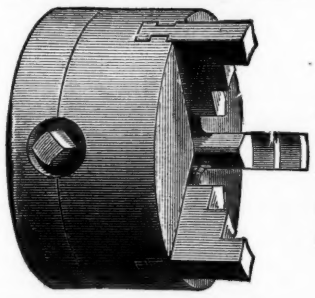

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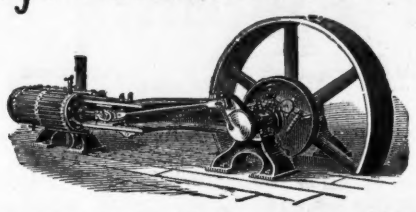

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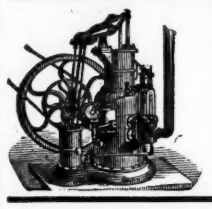

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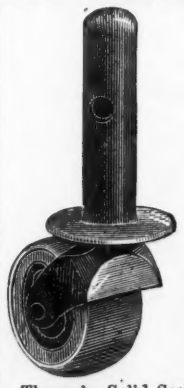

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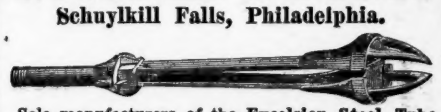

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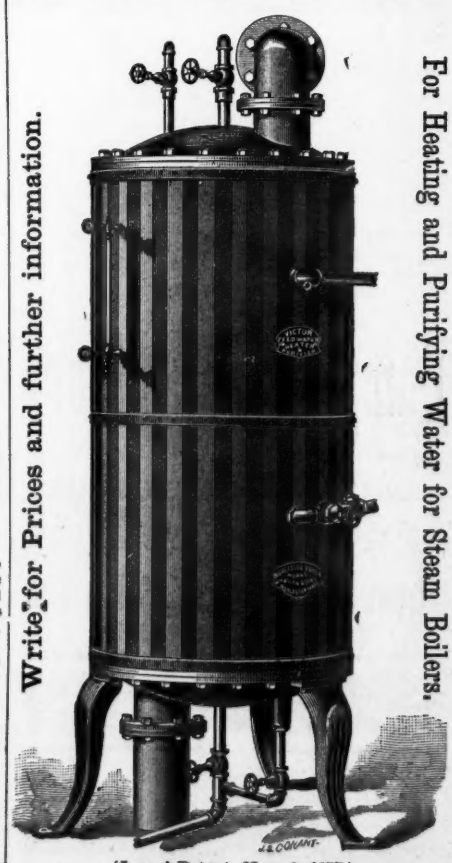

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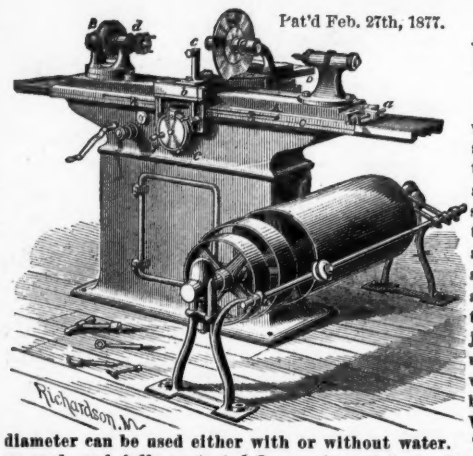

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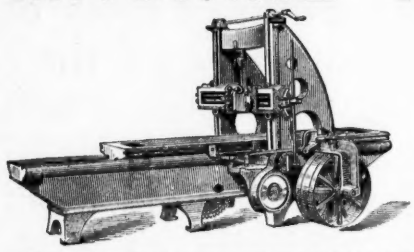

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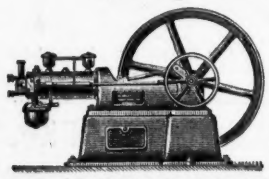

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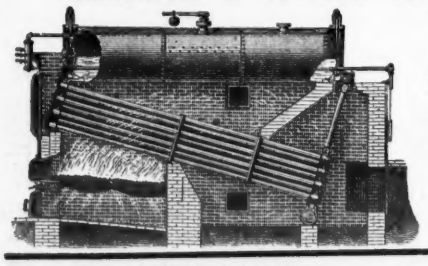

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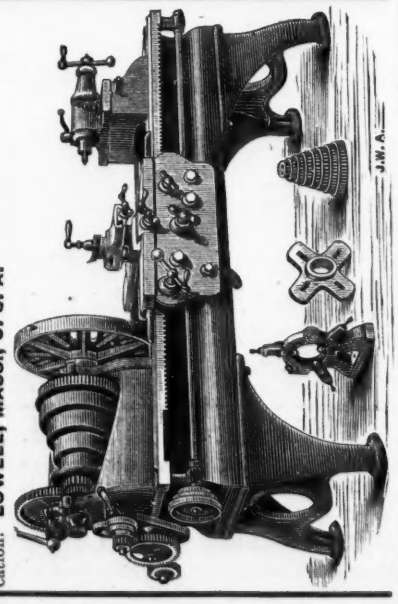

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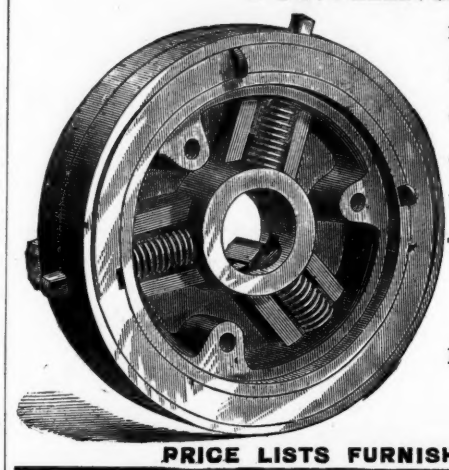

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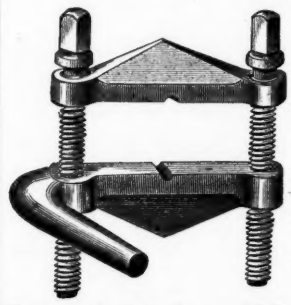

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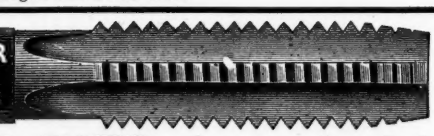

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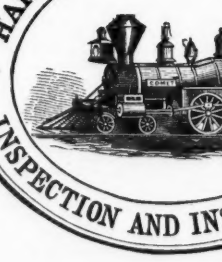

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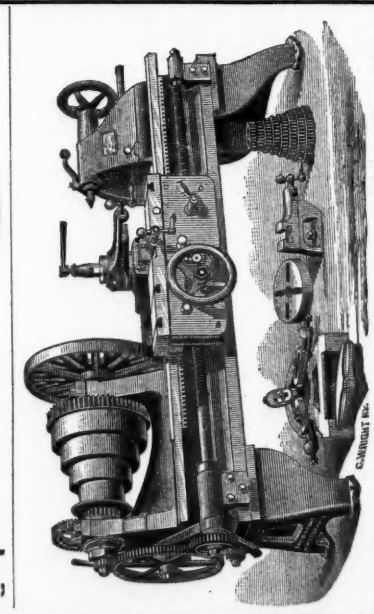

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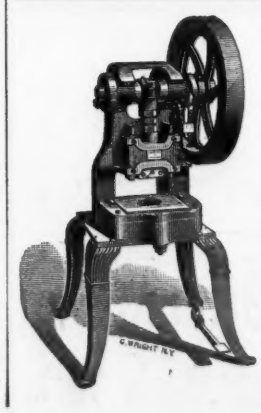

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